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AN extreme case, in some ways, of "careless blasting" occurred in New York last week, which failed of causing a serious loss of life and property by what we conceive to be a very narrow margin. On Third Avenue, between Thirty-eighth and Thirty-ninth Streets, an excavation is making for a building which is to occupy two lots, and the ingenious contractor, who probably never conceived that there could be such a thing as the vibratory transmission of force, thought it would save time and trouble if he should blow off with one blast that portion of the ledge of rock he was at work on, which extended across the front of both lots, and under the adjacent buildings. The ledge, which was about four feet below the level of the street, was drilled in seven places, and four of the shots which were to be fired at the same time by electricity were placed in six-foot holes, and we suppose that it was the firing of this quadruple shot which threw ten feet into the air a large mass of stone which landed in the street, demolishing in its fall the portable engine which operated the steam drills. The statement is made that the blast tore off a piece of the ledge eight feet deep, and extending across the front of both lots. If this is so, the blast would be a large one even for the open workings of a quarry, while for a situation in the midst of a crowded city it was criminal to the highest degree, and if, as the neighbors say, there is no department of the city that will acknowledge it can control the size or character of blasts, we feel that there is room for one more law at least on the overloaded statute books. The fact that the contractor was intelligent enough to take unusual precautions, warning the officials of the Elevated Railroad, stationing flagmen more than a block away on either hand, and heavily timbering over the blast, simply emphasizes the need there is that blasting should be done only by competent persons. Surely, if it is necessary to take out a license to "keep and sell gunpowder," it would not be unreasonable to allow none but licensed experts to explode it. It might be too much to require every blast to be prepared and fired by a mining engineer, but it would be eminently proper to pass and enforce a law that every charge having an explosive power above a fixed limit should be fired only under the supervision of such an expert. The temptation undoubtedly is for city contractors, who may have gained their knowledge of explosives on large engineering works where some of the nitro-compounds were used, to use the same substances for city work, and we do not believe that it is yet safe to place these compounds in the hands of rule-o'-thumb workmen. We think it extremely likely, too, that much of the blasting within city limits could be done with the new zinc or the older lime cartridges, both of which are used successfully in coal mines, and of which we have given descriptions.

THE Massachusetts Legislature has just failed to pass a bill — to become a law on its acceptance by the Boston City Council—establishing the office of fire-marshal for that city. The marshal was to be appointed by the Governor for the term of three years, while his salary of three thousand dollars was to be paid by Suffolk County, that is, mainly by Boston, provided that it and the working expenses of his office should not exceed one-fourth of the tax paid into the city treasury by the insurance companies who write risks on Boston buildings. Besides investigating the cause of every fire and reporting thereon to the fire-commissioners, it was to be his duty in cases where incendiarism was suspected, to follow up the clues and collect the evidence for submission to the district attorney. It seems very proper that a marshal's salary should be paid indirectly by the underwriters, since it is for their distinct benefit that some public official should be charged with the investigation of incendiary fires and the prosecution of the offenders, a task which is now left to the care of chance or the implacability of private revenge. We do not believe, however, that the fire-loss, so far as it is caused by incendiarism, would have been greatly checked by the marshal's efforts, for the reason that we believe that there are comparatively few incendiary fires, even fewer than the careful *Chronicle* catalogues in its tables. We find it stated in these tables that 1,731, or less than thirteen per cent of the 14,197 fires which occurred in the United States during 1885, had an incendiary origin — we trust that the *Chronicle* can support its statements by producing proof of the conviction of at least one thousand incendiaries. A separate table which shows the ratio of incendiary fires to the total number, makes the percentage for 1885 twenty-six, or double that which we deduce from the large table. Why there should be such a discrepancy we do not understand, and, though it discredits the accuracy of the one and the other, and perhaps emphasizes the difficulty of determining what are incendiary fires, we can secure another factor in the problem from this second table, and that is that in the most thickly-settled States the ratio of incendiary fires to the total number of fires is much less than in States where the population is more scattered and social obligations less observed; for instance, we find that in Kentucky this ratio was sixty-six while in Massachusetts it was only twenty-two; in Texas it was fifty, in New York twenty-four. This makes it a fair inference that a relatively small number of incendiary fires occur in communities that are likely to maintain fire-marshals, and though the suppression of incendiarism might have formed an important part of the new marshal's work, we do not think his researches would have thrown much light on the real origin of fires until he had discovered how to endow careless employés with moral courage enough to confess just what act of theirs had brought about the loss of their employer's property.

IN a paper read before La Société de Statistique de Paris in March last, Doctor Choquet discussed the ordinances which at present regulate the construction of theatres and places of amusement, and define the precautionary measures which must be observed during the performances. Much of what he says is of local interest only, so that it is not worth while to follow his entire argument, but he makes several excellent suggestions, which can be adopted as well in this country as in France. Premising with the statement that since 1751 there are records of the burning of seven hundred and twenty-seven theatres, and that, while in the first decade of this period only four were burned, the number of places of amusement burned during the first half of the present decade had risen to one hundred and seventy-four, he makes a good point against the alarmists by reminding them that not only the number of theatres increases from year to year, but also the number of performances given in each, so that the ratio of fires to the number of performances—the commonest cause of disaster—probably does not increase. To the same consolatory conclusion we can come by considering the number of persons destroyed by theatre fires. It is rather appalling to learn that since 1751 six thousand seven hundred and fifty-three lives have been lost at the burnings of theatres, but a little computation will show that the loss has been infinitesimal in comparison with the opportunities. For instance, there are in France three hundred and sixty-three places of amusement, and if we assume that the total number of such places in the world is only five times as great, that at each theatre are given only two hundred performances each year, and that the average attendance at each performance is only two hundred, we discover that the number of spectators who risked their lives by going to a theatre during the last decade exceeds the respectable figure of seven hundred and twenty-two millions. Then assuming that the loss of life might have been as great as it was in the decade 1841–50, when it was greatest, and two thousand one hundred and forty-four

persons fell victims to theatre fires, we discover that a similar loss would represent less than twenty-nine ten-thousanths of one per cent of the total number of spectators. As the factors we have used in this calculation are probably below the mark, we feel confident that in comparison with the fatalities which might overtake the same number of ordinary passers through the streets of the world it is rather safer for an individual to spend a couple of hours in a properly built and carefully conducted theatre, than to pass them in wandering about the streets. It would be a curious inquiry — which we commend alike to the attention of clergymen and theatre-managers, whose views of propriety are oftentimes so at variance — to discover how many churches had been burned throughout the world since 1751, and how many lives had been sacrificed to religious zeal—or its simulation.

DOCTOR CHOQUET approves of most of the regulations now in force — regulations the virtue of which is also acknowledged in this country, and their observance insisted on. But he finds some of them open to improvement: for instance, he suggests that all windows in the dressing-rooms, and other dependencies of the stage, should be glazed with sheets of mica set in wire frames, instead of the usual glass in wooden sashes, arguing that in case of fire they will not burst as soon as heat touches them, and so admit fresh air to quicken the combustion. The lantern or ventilator now usually built over the stage to act as an escape for smoke in case of fire should be left unglazed, or glazed with glass, which would give way at the first touch of flame. He also recommends that, for the same reason, mica should be used for the sides of the oil lamps, which must be lighted, in addition to gas and electric lamps, during a performance, in all passages and stairways; and as all the air suitable for combustion would be consumed by the conflagration, it is necessary, if these oil lamps are to burn steadily or at all in the hour of peril, that they should each be provided with a special fresh-air supply. As to fire-curtains, he believes that the ordinary drop-curtain should be essentially a fire-curtain, say, of wire-cloth embedded in fibre, upon which the usual decoration could be painted, and besides this there should be in front of it a regular fire-curtain made, not of wire-netting, as usual, but of laminæ of corrugated iron, which would wholly prevent the egress into the auditorium of smoke and gases generated on the stage. Each of these curtains should be held up by ropes which, being burned or cut by some employé, would allow the curtains to drop automatically; but to make sure that a fire occurring on any part of the stage should lower the curtain, these ropes should be led to every part of the stage — a difficult thing to arrange. But as this is at best but a blundering device, he urges that in addition to this quasi-automatic arrangement, the management of the curtains should be under the control of some one in a well-protected and isolated position. In short, he attaches more importance to the care, prudence, and intelligent activity of the theatre hands than to any automatic contrivances, and, indeed, specially states that automatic-sprinklers, good as they are, are only suited to small theatres which cannot maintain a properly-organized fire-watch. As to who would make the most serviceable members of this corps, he makes the excellent suggestion that past members of the corps of *sapeurs-pompiers* would be of the utmost value as stage-hands, scene-shifters, and so on, because of their experience in handling fires. This idea seems so sensible that we recommend to municipalities which retire firemen and police-officers who have reached a certain age, in spite of their being still capable of active work, that they should arrange with the theatre-managers of their respective towns to take on as stage-hands and ushers these discharged veterans whose pensions are quite inadequate to their support.

DR. C. S. W. COBBOLD, the resident physician of the Earlswood lunatic asylum in England, recently published, in collaboration with Messrs. Berry and Burmeister, architects, of London, some plans for a model asylum. A correspondent of the *British Architect* criticised the plans, and Dr. Cobbold replied, giving incidentally some suggestions in regard to the planning of hospitals of this kind which seem to us of great importance. The *British Architect's* critic having pointed out that no rooms were set apart for the reception of patients, Dr. Cobbold answered that his scheme provided for a single ward for each sex, to be assigned to "recent and convalescent" cases. In his practice he had observed that convalescent patients exercise a most soothing and cheering influence on those newly admitted; the latter, deriving from the appearance of the others hopeful inferences as to their own recovery, while the mingling of the happy and contented convalescents among the new patients helps to make the latter feel themselves quickly at home. In his opinion it is of the greatest importance to make the insane feel that they are not prisoners, but patients, who have come to the asylum for medical treatment, and it is often useful, for this reason, to take new cases to the sick-wards, where they find their mental disease placed on the same footing as the physical diseases of those about them. In regard to the dormitories for the acute cases, Dr. Cobbold remarks that the plan now most approved is to place such patients in "observation" dormitories, consisting of a large room for the quieter patients, and small rooms for the others, separated by doors with the upper panels either open or glazed with very thick plate glass, so that the attendant, as he walks up and down the ward, can observe the patients in the small rooms without disturbing them by opening the doors.

THE attendants' rooms in Dr. Cobbold's plan are so placed that the only access to them is through the ward, this arrangement being adopted to allow the occasional supervision of the ward by the attendant at night, if any disturbance should occur, or if a patient should have occasion to call him; as well as to secure a certain supervision of the attendant himself by the inmates of the ward. The day-rooms, in this plan, are purposely made large, so that a considerable number of patients can assemble in them, not only for economy of attendance, but because the association of so many patients is rather beneficial than otherwise to them. In regard to the barring of the windows, which the *British Architect's* critic rather sentimentally thinks "ought surely not to be necessary in modern asylums," the Doctor says that "it is necessary even in modern asylums to provide windows of such a kind that the patients cannot get out of them, either by accident or design." The first duty of an asylum superintendent is, he thinks, to prevent the escape of patients who are dangerous to themselves or others, and to effect this the windows must be secured, although it should be done in such a way as to make the building look as little prison-like as possible.

SOME cities which have for the past few years been following the fashion set by New York in the erection of large and small apartment-houses are beginning to regret the sudden craze for living in flats, as the taste for this style of dwelling seems to be waning. Among the Eastern cities, New York stands almost alone in its continued liking for this decidedly French way of living, and the demand for flats there, appears to be permanent. Capital invested in apartment-houses yields a good return, and there is no trouble in finding tenants. The length of time required to reach those outlying places which afford comfortable houses at anything approaching moderate cost tends to make the New York business man cling to his flat. For those whose income falls within, say $5,000, this modern substitute for a home fills a want that nothing else could fill. The elevated railroads afford quick transportation between bed-rooms and business, and the average New Yorker is so wedded to his suite of five or eight rooms that he does not realize the existence of any more complete and satisfactory way of living. Just across the bridge, in Brooklyn, however, there is quite a different state of affairs. A craze for apartment-houses sprang up in Brooklyn three or four years ago, and buildings of that class went up in all sections of the city. A reaction has set in now, and flats are not nearly so popular as they were a year or two ago. In many cases it is impossible to find tenants, and real estate owners who remodelled their houses to meet the prevailing taste are in despair. Boston capitalists, with true Boston conservatism, have probably kept well outside the danger-line in this matter, and as a rule money has not been put into apartment-houses much faster than good business policy authorized. Most of these houses are well and permanently tenanted, and yet some of the most desirable suites, as far as external appearances go, seem to be steadily in the market for rent. Apartment-house living cannot be said to be generally in favor with those people who transact the business of Boston, and life in the suburbs is growing more and more desirable. When quick and comfortable transit shall be provided between the city proper and the beautiful territory that lies all around it, a state of things which can hardly be delayed for many years more, those who are now forced to live in flats will become the happy possessors of suburban homes.

AN EDITOR'S TRIP ABROAD. — II.

LONDON, June 11, 1886.

IT seems to me strange that no one should ever have thought of writing a treatise on the political importance of the English prayer-book. Perhaps it has been done, but if not, I should say, judging from the curious reflections which occurred to me in the course of last Sunday's services on board the *Catalonia*, that it would be a good subject for somebody. On the Cunard steamers, and, I presume, on those of all the other first-class English lines, it is the rule that the captain, either in person or by some acceptable deputy, shall read the service of the Church of England every Sunday morning, and the crew and passengers are required or invited to be present. In our case a general notice of the service was given to all cabin, steerage and intermediate passengers, and the saloon was comfortably filled at the appointed hour with auditors of all three classes, each one of whom found a pretty prayer-book ready for him, stamped with the Cunard seal, and containing the service and the hymns. During the reading, the saloon skylight, which opened through the portion of the deck reserved for the steerage passengers, was darkened from time to time by the apparition of a head, wearing anything but a sympathizing expression, and as I thought of the crowd of men and women on the deck above us, outnumbering the cabin passengers more than ten to one, who would have regarded any participation in the simple service as a serious sin, I began to reflect upon the thousands of instances in which, as the Sunday sun threw its beams over the revolving earth, it would shine upon the same spectacle — a handful of Englishmen saying their prayers calmly together in the middle of an unfriendly multitude, whose hostility or whose courage stopped just short of actual menace. To say nothing of Great Britain itself, the history of the conquest and government of India shows nothing, one might say, more plainly than the power of the mutual support which, aside from the force of organization, Englishmen get in some way from their forms of religious service. The character of their belief has nothing to do with the matter; the secret appears to lie mainly in the accident which led the compilers of the Book of Common Prayer to engage the auditors as well as the minister in the service, so that the Anglo-Saxon on Sunday, instead of gazing mutely at the gold lace on a priest's back, or crawling about a temple floor and knocking his head on the pavement, stands up like a man before his Creator, acknowledging his own sins, and asking, for others as well as himself, mercy and forgiveness; and, like Antæus, refreshed by contact with the earth, he rises from his knees each week with a renewed confidence in the sympathy and support of his fellow-believers, and renewed thoughts of home and duty and eternal happiness, which sustain him, as nothing else can, through the trials which may beset him until the Sunday comes round again. A great deal has been said about the desperate courage which is inspired in Mussulman soldiers by their conviction that if they die fighting for their faith they will enter at once into their rather æsthetic Paradise, and there is no doubt that when death is very near, such considerations have great importance; but the future to which an Englishman who does his duty looks forward is as much more inspiring than that of the Moslem, in the encouragement which it offers to noble deeds, as the habit of candid self-examination and repentance which his religion inculcates is superior, in training him in justice and self-control, to the blind Asiatic fanaticism. I should not care to risk pushing the comparison too far, but it is certainly singular that the great career of the English as conquerors and administrators should have begun with the quarrels of Henry the Eighth and the Pope, and the establishment of the English Church. We are often told that the success of the British in dealing with foreigners is due to their brutality, and that they have simply elbowed themselves into prominence in the world; but they certainly did not discover the use of their elbows for the first time in the reign of Elizabeth, and something else must have been needed to give them that faith in each other's support which has carried them, as it did the Romans, to permanent success in so many enterprises where other nations, stronger than they in the first attack, had failed.

The conclusion of these cogitations was postponed, in the present instance, by the announcement, at the termination of the service, that land was clearly visible to the north of the ship, and the auditors speedily found their way to the deck, to observe the rather unusual spectacle of the Irish coast, lying clear and unclouded from Fastnet Island to Queenstown. The night after leaving Queenstown was clear, but, just before we reached the bar at the mouth of the Mersey, the belated Irish fog caught up with us, and after crawling slowly about in the shallow waters, with the whistle blowing and the sounding-leads busily at work on both sides of the ship, we came to anchor in the mist, and there remained until the middle of the afternoon, when the clouds lifted sufficiently to enable us to go on to the usual anchorage, from which the tenders took us to the landing-stage just in time to miss all the evening trains for London.

The custom-house examination at the landing-stage was much less disagreeable than I had expected. Of late years the baggage of passengers from the United States has been rigidly examined, in search of fire-arms and explosives, neither of which are allowed to enter the country in that way, and we had heard a good deal of the annoyance which American tourists had been made to suffer, so that we were agreeably surprised at the rapidity and courtesy with which the examination was made. Before reaching the anchorage at Liverpool, all the baggage of the passengers, including their state-room trunks, as well as those in the hold, was brought out and piled on the part of the deck appropriated to the intermediate passengers. The trunks and boxes not marked with the owner's name or initials were then ornamented with large initial letters printed on paper and pasted on the trunks, indicating the names of the proprietors, and as soon as the small tender, for the steerage passengers, arrived alongside, all the baggage was transferred into it and sent up to the landing-stage, while the cabin passengers were going on board the large tender reserved for their use. On the arrival of this at the landing-stage, the passengers were, after a brief delay, admitted into a long room, on the wall of which were painted the letters of the alphabet, and under each letter a group of the trunks and boxes belonging to passengers whose names began with that letter. It was thus very easy to find one's trunks, and a few moments sufficed to unlock them, call one of the pleasant, business-like custom-house officers who stood inside a little barrier formed by a narrow raised platform on the floor, and have his experienced hand search every corner of each one, without any serious disarrangement of the contents. The examination over, a small paper label was pasted on each trunk, and a porter of the transfer company stood ready to take them to the baggage-wagon, which, for sixpence apiece, carried them to the Adelphi Hotel, while we amused ourselves by walking there. Never having been in Liverpool before, I was rather struck with the beauty of the buildings. In Water Street, the principal business street, where we stopped on our way, to engage our return passage, there was an immense amount of well-studied and splendidly executed detail, on buildings which were precluded by the narrowness of the street from having any sky-line; but in the wide spaces beyond, extending from St. George's Hall and the Exchange to the hotels and railway stations, there was plenty of charming silhouette, while nearly every building showed the thoughtful arrangement and form of openings, and elegance in the proportioning of heights of stories, and projection and size of string-courses, which, to an architect, give far surer evidence of professional skill than mere richness or novelty of design.

Of novelty, however, there was a good deal, exhibited often in a modest way which was particularly pleasing. Taking advantage of the length of the summer evening, we hurried through our dinner, and then went out and hailed one of the "tram-cars," which were continually passing the front of the hotel, and, mounting to the top, rode to the end of the line and back again. This particular line took us among scenery varying from that of the noisy pierhead, or entrance of the docks, through more and more quiet, suburban streets, to "Dingle," a lovely park just outside the town, now enclosed and set apart for hospital purposes. Although Liverpool, judging from St. George's Hall, which looks as if it were built of coal, seems to be quite as smoky a place as London, the aspect of the streets of little shops and houses through which we passed was quite different from that of the hideously monotonous London streets of the poorer sort. I have never particularly fancied the so-called "polychromatic architecture," and imagine that most architects concede the more conspicuous examples, such as the Opéra at Paris, and Scott's Government offices in Whitehall, to be failures, but hundreds of the little Liverpool shop-fronts were varied with color alone in a manner which one could not help finding pleasant, to say the least. One of the commonest methods of getting effect was to lay the fronts in old English bond, putting alternate headers and stretchers in each course, and to have all the heads enamelled. The rain seems to keep the enamelled surfaces clean long after the ordinary bricks between them have turned black, and they give a regular mottling to the wall, which is much better than no decoration at all. I should say that a still more interesting effect might be obtained by using the same materials with a different bond, such, perhaps, as the French *liaison en croix*, or our own common bond of a continuous row of headers every fifth or seventh course, and perhaps a blue enamel might be pleasanter than the white, but it is evident, from the more ambitious examples which stand near these that simplicity of design is essential to success in such work.

THE EARLY WORKS OF MUNKACZY.— A Vienna gentleman went to see Munkaczy in Paris the other day, and explained that he would like to buy some pictures by him; "only," he added, "I cannot afford to pay the price you now ask. Could you tell me where I could find some of your early work, painted when you were a young man in Hungary — something that I could buy cheap?" "Certainly; there are two or three hundred in my native village of Munkacz — the houses I painted when I was Michael Leib, painter and glazier."

[1] Continued from page 294, No. 547.

NOTES AND DATA ON RADIATORS, HOT-AIR PIPES, AND REGISTERS FOR STEAM HEATING.—II.

COMPOUND COIL RADIATORS.

STATUE OF FAME
Modelled by Dejoux to surmount the Dome of the Pantheon - Paris, but never carried out intended in Bronze 27 feet high.

FOR several years Messrs. Edward E. Gold & Son, of New York, have been experimenting on an extended-surface radiator, made by winding coils of square wire of strong elastic tension around the one-inch pipes of common pipe radiators. These radiators have proved a decided success, doing more work, per cost of radiator, than any other radiator with which they have been tested and are now in the market. These radiators were made the subject of a careful series of experiments by William J. Baldwin, M.E., and Mr. F. W. Wright, the results of which were presented in a paper to the American Society of Mechanical Engineers at its meeting in Boston, November 10 to 13, 1885, and published in the *Sanitary Engineer*, November 26, 1885. From these experiments it was found:

1. That the compound-heater, two pipes in height, and of about the same floor-space occupied by the "pin" radiator, would condense equal or greater quantities of water with equal or greater results in air-warming; and that this radiator may be confidently asserted to be equal to any now in the market.

2. That with the same amount of water condensed the compound-coil heater raised the same amount of air to a *higher temperature* than did the pin radiator with which it was compared. This was accounted for in that the amount of heat lost by radiation in the pin radiator was much greater than in the case of the compound heater.

3. That the passage of air through the compound coil was less impeded than through the pin radiator. In buildings where forced ventilation is employed, this is an advantage of considerable importance, as the writer has often witnessed the extreme difficulty with which the air was drawn through the pin radiators, especially when slightly clogged up with dust and dirt.

These heaters, when cased, are all, twenty-six inches high and forty-nine inches long over all. The width varies according to the amount of heating-surface, as follows: —

Heating Surface. Sq. Feet.	Width over all, including Casing, ins.	Heating Surface. Sq. Feet.	Width over all, including Casing, ins.	Heating Surface. Sq. Feet.	Width over all, including Casing, ins.
24	11	64	23½	104	36
32	13½	72	26	112	38½
40	16	80	28½	120	41
48	18½	88	31	128	43½
56	21	96	33½		

In adapting this radiator to direct radiation, a great improvement has been made upon the usual mode of heating. Owing to the open character of the coils, it was necessary to protect them from dust, etc., by a casing, which is generally of japanned sheet-iron, and it was soon found that by putting registers in the top of the casing, and leaving the bottom open, the temperature of the room could be easily controlled by opening or closing the registers, without shutting off the steam. It will be seen that these heaters do not heat the air by radiation, but by induction, the air passing through the coils and receiving heat from contact with them. The constant circulation of the air in the room caused by this method of heating, also warms the room more evenly than is the case with the common radiator.

These heaters are made either round or rectangular, as desired.

COMPUTATION OF HEATING SURFACE AND DIMENSIONS OF PIPES AND REGISTERS.

To compute the amount of surface required for heating by indirect radiation, the amount of air to be heated per hour in cubic feet should be computed, and from Table IV the amount of air which one foot of radiating-surface will warm in an hour can be found.

This table is based upon the number of heat units that one foot of surface will give off per hour, per degree of difference between the temperature of the steam in the radiator and the air in which it is placed. The number of units must evidently be determined by experiments. The number of heat units given out by one foot of radiating-surface depends in a great measure upon the velocity with which the air passes over and through the radiator; more units being given out when the air is drawn rapidly over the radiator, than when it moves slowly. Hence the rapidity with which the air passes through the radiator must be taken into account in determining the amount of heating-surface.

As a general rule, the air should not move over the radiators in cold weather faster than 300 cubic feet per square foot of radiating surface per hour. Columns 2 and 4 of Table IV are based upon the natural velocity of the heated air, caused by the heat from the radiator alone; the number of heat units per square foot of radiating-surface, per degree difference between the steam in radiator and the fresh air given out per hour, being taken at 1.8.

Columns 3 and 5 gives the number of cubic feet of air which one nominal foot of Gold's pin radiator will heat to 100 and 120 degrees, with a velocity of 300 feet per square foot of radiating-surface per hour. The quantities being based upon the supposition that one foot of surface gives out three heat units per hour per degree difference in temperature between the steam in radiator and the air supplied to it.

TABLE IV.

QUANTITY OF AIR WARMED PER HOUR, BY ONE SQUARE FOOT OF INDIRECT HEATING-SURFACE, WITH NATURAL OR FORCED DRAUGHTS.[2]

Steam pressure above Atmosphere.	Cubic feet of air warmed per hour.			
	100° to 110° F.		0° to 120° F.	
	Natural Draught.	Forced Draught.	Natural Draught.	Forced Draught.
lbs.	Pipe and pin.	Pin.	Pipe and pin.	Pin.
0	150	251	125	208
3	160	267	133	223
5	165	276	138	229
10	177	296	148	246
20	198	330	165	275
30	212	353	177	294
60	245	408	204	340

The writer believes these tables to be as correct as they can be made, with the limited amount of experimental data obtainable.

It has been the almost universal custom of steam-heating companies to estimate the indirect heating surface by rule of thumb, the same as for direct radiation, the only difference being that they doubled the amount of surface for indirect radiation. This did very well where there was no special system of ventilation, but with the

[1] Continued from page 269, No. 545.
Under the head of "Direct Radiation," in the preceding paper, the following table, showing the space occupied by the Bundy Radiator, should have been given:

TABLE III.

DIMENSIONS OF THE BUNDY LOOP CAST-IRON RADIATOR 36 INCHES HIGH.

SINGLE ROW OF LOOPS.

No. of Loops.	Heating Surface. sq. ft.	Length. ft.	Length. in.	Width. in.	No. of Loops.	Heating Surface. sq. ft.	Length. ft.	Length. in.	Width. in.
3	9	1	1	6½	13	39	3	9	6½
4	12	1	4	"	14	42	4	0	"
5	15	1	7	"	15	45	4	3	"
6	18	1	10½	"	16	48	4	6½	"
7	21	2	1	"	18	54	5	1	"
8	24	2	5½	"	20	60	5	7	"
9	27	2	8	"	22	66	6	1½	"
10	30	2	11	"	24	72	6	8	"
11	33	3	3	"	26	78	7	2	"
12	36	3	5	"					

TWO ROWS OF LOOPS.

6	18	1	1	10½	24	72	3	6	10½
8	24	1	4½	"	26	78	3	9	"
10	30	1	8	"	28	84	4	1	"
12	36	1	11	"	30	90	4	3½	"
14	42	2	2	"	32	98	4	6½	"
16	48	2	5	"	40	120	5	7	"
18	54	2	8	"	44	132	6	1	"
20	60	2	11	"	48	144	6	8	"
22	66	3	2½	"	52	156	7	2½	"

THREE ROWS OF LOOPS.

9	27	1	1	14	27	81	2	8	14
12	36	1	4½	"	30	90	3	0	"
15	45	1	7	"	33	99	3	3	"
18	54	1	11	"	36	108	3	6	"
21	63	2	2	"	39	117	3	10	"
24	72	2	5	"	45	135	4	4	"

FOUR ROWS OF LOOPS.

16	48	1	5	18½	72	216	5	0½	18½
20	60	1	7	"	80	240	5	7½	"
24	72	1	11	"	88	264	6	1½	"
40	120	3	0	"	96	288	6	8	"

CIRCULAR RADIATORS, 36 INCHES HIGH.

No. of Loops.	Heating Surface.	Outside diameter of base.	No. of Loops.	Heating Surface.	Outside diameter[1] of base.
10	30	1 4	26	78	2 0½
15	45	1 7½	31	93	2 3½
20	60	1 9½	50	150	2 6½
22	66	1 9½	72	216	3 1½

IN HALVES TO ENCIRCLE COLUMNS.

		Outside diameter.		Inside diameter.				Outside diameter.		Inside diameter.	
26	78	2	2		9						
34	102	2	6½	1	1½	50	150	3	0	1	7½

[2] In this table the quantities given for forced draughts are for the pin radiators and Gold's compound coil-radiators only, as the writer could obtain no reliable data of the heat units given off by pipe radiators under forced draughts. This table is computed in the same way as line "C" in Table XIII of "*Steam Heating*," by Robert Briggs, Van Nostrand Science Series.

improved systems of ventilation now employed, such rules of thumb certainly do not reflect much credit upon those who have to do with the heating of large public buildings.

QUANTITY OF AIR TO BE HEATED AND DIMENSIONS OF HOT-AIR PIPES.

It is evident that the area of the cross section of the hot-air pipes will depend upon the amount of air that is to pass through them in a given time. This leads to a consideration of how much air we must heat.

With ordinary systems of automatic ventilation, with nothing but vertical ducts capped with some form of "ventilator," it is impossible to change the air of a room oftener than four times an hour, without overheating the rooms, and in most cases it would be safe to reckon upon three times. Hence the amount of air to be heated per hour in cubic feet will be found by taking the cubical contents of the room, deducting for space taken up by furniture, etc., and multiplying by three or four, as it may be deemed advisable. This will give the number of cubic feet of air that must pass through the hot-air pipes per hour. For this class of ventilation it is not safe to reckon upon a velocity of the air in the pipes at more than 50 cubic feet per square inch of cross-section per hour for the first story, and 70 cubic feet per square inch per hour for the rooms above. Divide the amount of air to be heated per hour by these numbers, and it will give the required area of the hot-air pipes in square inches.

The size of the register will be governed by the size of the pipe. Table V gives the dimensions of rectangular registers as made by the Tuttle Manufacturing Company, and Table VI the capacity of pipes and registers.

TABLE V.

DIMENSIONS OF REGISTERS AND VENTILATORS, MADE BY THE TUTTLE & BAILEY MANUFACTURING COMPANY.

Size as given on List.	Opening to admit Body of Register.	Extreme Dimensions of Register Face.	Depth of the Register.		Opening to admit Iron Border.
			Closed.	Open.	
4½ × 6½	4⅜ × 6⅜	5⅞ × 7⅞	1¼	1⅝	—
4 × 8	4 × 8	5½ × 9½	1⅛	2¼	—
4 × 10	4 × 10	5½ × 11¾	1⅛	2¼	—
4 × 13	4 × 13	5½ × 15	1⅛	2¼	—
4 × 15	4 × 15	5⅛ × 16⅞	1⅛	2¼	—
4 × 18	4 × 17⅝	5⅛ × 19¾	1⅛	2¼	—
6 × 8	6¼ × 8¼	7⅞ × 9⅞	1¼	2⅜	10½ × 12½
6 × 9	6¼ × 9	7⅞ × 10¾	1¼	2⅜	10½ × 13½
6 × 10	6¼ × 10	7⅞ × 12	1¼	2¼	10¼ × 14½
6 × 14	6¼ × 13¾	8 × 15⅝	1¼	2¼	10⅜ × 18½
6 × 16	6¼ × 16	8 × 17⅞	1¼	2¼	11⅛ × 21½
6 × 18	6 × 18	8 × 20	1¼	2¼	10⅜ × 23
6 × 24	6¼ × 24½	8 × 26	1¼	2¼	10½ × 28⅜
7 × 7	7 × 7	8¾ × 8	2	2¾	11⅛ × 11⅝
7 × 10	7 × 10	8¾ × 11¾	2	2¾	11⅛ × 14⅝
8 × 8	8 × 8	9¾ × 9¾	2	3	12⅜ × 12⅜
8 × 10	8 × 10	9¾ × 11¾	2	3	13 × 15
8 × 12	8 × 12	9¾ × 13⅝	2	3	13 × 16¾
8 × 15	8 × 15	9¾ × 16⅝	2	3	13 × 19¾
8 × 18	8 × 18	9¾ × 19¾	2	3	13 × 22⅝
9 × 9	9¼ × 9¼	10⅝ × 10⅝	2¼	3⅜	13⅜ × 13⅜
9 × 12	9 × 12¼	10½ × 13½	2¼	3⅜	14¼ × 17½
9 × 13	9¼ × 13¼	11¼ × 15¼	2¼	3⅜	14⅜ × 18⅜
9 × 14	9 × 14	11 × 16	2¼	3⅜	14½ × 19¼
10 × 10	10¼ × 10¼	12 × 12	2⅜	3⅜	15 × 15
10 × 12	10 × 12	11¾ × 13¾	2⅜	3⅜	15 × 17
10 × 14	10¼ × 14¼	12¼ × 16¼	2⅜	3⅜	15⅜ × 19⅜
10 × 16	10 × 16	12 × 18	2⅜	3⅜	15⅜ × 21½
12 × 12	12 × 12	14 × 14	2⅜	4¼	17⅜ × 17⅜
12 × 15	12¼ × 15½	13¼ × 16¾	2⅜	4¼	16⅜ × 19⅜
12 × 17	12¼ × 17½	14 × 19	2⅜	4¼	17⅜ × 22⅜
12 × 18	12¼ × 18½	14 × 20	2⅜	4¼	16⅜ × 23
12 × 19	12⅜ × 19¼	14⅜ × 21	2⅜	4¼	17⅜ × 21½
12 × 24	12 × 24	13⅞ × 25⅜	2⅜	4¼	17½ × 29½
14 × 14	14¼ × 14¼	16⅜ × 16⅜	2⅜	3⅞	20¼ × 20¼
14 × 18	14¼ × 18¼	16½ × 20½	2⅜	3⅞	20¼ × 24
14 × 22	14¼ × 22	16⅜ × 24½	2⅜	4	20¼ × 27¾
15 × 25	15⅜ × 25½	17⅜ × 27⅝	3⅜	5⅝	22 × 32
16 × 16	16 × 16	18⅜ × 18⅜	3	4½	22 × 22
16 × 20	16¼ × 20½	17⅜ × 22⅝	3	4½	21½ × 25½
16 × 24	16⅜ × 24½	18⅜ × 27	3	4½	22 × 30⅛
20 × 20	20¼ × 20¼	22¼ × 22¼	3½	5½	26¾ × 26¾
20 × 24	20 × 24	22¼ × 26	3½	5½	26 × 29½
20 × 26	20¼ × 26¼	23⅝ × 28⅜	3½	5½	27¼ × 33½
21 × 29	20⅞ × 29	23⅝ × 31½	3½	5½	28 × 36
24 × 24	24 × 24	26¼ × 26¼	—	—	—
27 × 27	27 × 27	29½ × 29½	3½	5⅝	34 × 34
27 × 38	27 × 38	29¼ × 40¼	4½	6½	34 × 45
30 × 30	30¼ × 30¼	32⅝ × 32⅝	4½	7	37¾ × 37¾

TABLE VI.

ESTIMATED CAPACITY OF PIPES AND REGISTERS.

ROUND PIPES.

Diameter of pipe.	Area in sq. inches.	Diameter of pipe.	Area in sq. inches.	Diameter of pipe.	Area in sq. inches.
7 inches.	38	12 inches.	113	22 inches.	380
8 "	50	14 "	154	24 "	452
9 "	63	16 "	201	26 "	531
10 "	78	18 "	254	28 "	616
11 "	95	20 "	314	30 "	707

RECTANGULAR PIPES.

Size of pipe.	Area in sq. inches.	Size of pipe.	Area in sq. inches.	Size of pipe.	Area in sq. inches.
4 × 8	32	8 × 20	160	12 × 18	216
4 × 10	40	8 × 24	192	12 × 20	240
4 × 12	48	10 × 12	120	12 × 24	288
4 × 16	64	10 × 15	150	14 × 14	196
6 × 10	60	10 × 16	160	14 × 16	224
6 × 12	72	10 × 18	180	14 × 20	280
6 × 16	96	10 × 20	200	16 × 16	256
8 × 10	80	12 × 12	144	16 × 18	288
8 × 12	96	12 × 15	180	16 × 20	320
8 × 16	128	12 × 16	192	16 × 24	384

REGISTERS.

Size of opening.	Capacity in sq. inches.	Size of opening.	Capacity in sq. inches.	Size of opening.	Capacity in sq. inches.
6 × 10	40	10 × 14	93	20 × 20	267
8 × 10	54	10 × 16	107	20 × 24	320
8 × 12	64	12 × 15	120	20 × 26	347
8 × 15	80	12 × 19	152	21 × 29	406
9 × 12	72	14 × 22	205	27 × 27	481
9 × 14	84	15 × 25	250	27 × 38	684
10 × 12	80	16 × 24	256	30 × 30	600

ROUND REGISTERS.

Size of opening.	Capacity in sq. inches.	Size of opening.	Capacity in sq. inches.	Size of opening.	Capacity in sq. inches.
7 inches.	26	12 inches.	75	20 inches.	209
8 "	33	14 "	103	24 "	301
9 "	42	16 "	134	30 "	471
10 "	52	18 "	169	36 "	679

For buildings in which forced ventilation is provided, either by a fan or an aspirating-shaft, the amount of air to be heated should be determined by the number of occupants, if the rooms are continuously occupied by a number of people. Where possible, 3600 cubic feet of air per hour should be allowed to each person, and on no account should less than this amount be provided for hospitals and rooms in which sick people are confined. For schools, 30 cubic feet per minute, or 1800 cubic feet per hour, is recommended, but it is very seldom that more than 1200 is provided, and often not half of this latter amount. In the Boston school-houses built within the past two years, from 15 to 25 cubic feet per minute for each scholar is *actually* provided. In these buildings ventilation is produced by a fan placed in the top of the building, drawing the air from the rooms. The velocity of the air in the hot-air pipes where forced ventilation is employed may be assumed at 146 feet per hour per square *inch* of cross-section. Having settled upon the amount of air to be provided, and the velocity of the supply, the areas of the pipes can be computed as already described.

Example I.—How many feet of radiating surface will be required to heat an office room in the third story, 15 feet by 20 feet, 12 feet high, heated by indirect radiation and automatically ventilated?

Ans.—Cubic contents of room = 3600 cubic feet. Allowing the air to be changed four times per hour, we have the number of feet per hour to be heated, 14,400 cubic feet. Assuming that the boiler will be run at three pounds pressure on the average, and that it is only desirable that the air should issue from the registers at 110°, we find from Column 2, Table IV, that one foot of heating-surface will warm 160 feet, and to warm 14,400 feet will therefore require 90 feet of radiating-surface. The hot-air pipe should have an area of 14,400 ÷ 70 = 205 square inches, which would require a 16-inch pipe and a 16-inch × 24-inch register.

Example II.—Compute the radiating surface (pin radiators), dimension of hot-air pipes, and size of registers, for heating a primary school-room, 24 feet by 32 feet by 12 feet, containing fifty-six scholars; it being required to supply each scholar and the teacher with 20 cubic feet of air per minute, the room being ventilated by means of a fan, and the air to come from the registers at a temperature of 110°, steam pressure of three pounds.

Ans.—Amount of air to be heated per hour = 57 × 20 × 60 = 68,400 cubic feet. From Table IV we see that one foot of pin radiating surface will heat 267 cubic feet of air per hour; hence the amount of radiating surface should be 68,400 ÷ 267 = 280 square feet. It would be best to divide this into two stacks of fourteen sections each.

The hot-air pipes should have a combined section of 68,400 ÷ 146 = 468 square inches, which would require two 16-inch pipes, and 16-inch by 24-inch registers. As a general thing the pipes are made smaller than this, but it requires more force to pull the air through.

F. E. KIDDER.

THE ILLUSTRATIONS

Contributors are requested to send with their drawings full and adequate descriptions of the buildings, including a statement of cost.]

HOUSES OF J. F. ANDREW, ESQ., BOSTON, MASS., MESSRS. MCKIM, MEAD & WHITE, ARCHITECTS, NEW YORK, N. Y., AND OF MRS. NATHANIEL THAYER. MESSRS. PEABODY & STEARNS, ARCHITECTS, BOSTON, MASS.

[Gelatine Print, issued only with the Imperial Edition.]

HOUSE OF H. C. HULBERT, ESQ., CLIFTON, O. MESSRS. PLYMPTON & TROWBRIDGE, ARCHITECTS, CINCINNATI, O.

FIRST story walls two and one-half feet thick, and built of field-stone or boulders laid in Portland cement. Trimmings around doors and windows of Bedford bluestone, tooth-chiselled work. Second story and gables are framed of 6″ x 8″ posts, 6″ x 6″ and 6″ x 4″ girts, and plates filled in with a 4″ brick wall, and cemented on outside, finishing with Waring's Georgia (buff) cement. The house is sheathed on inside, and furred for lathing and plastering. All the woodwork on exterior is composed of Mississippi cypress. The roof will be of reddish-brown ⅜″ thick, tiles laid in cement. All fireplaces

are lined with vitrified, salt-glazed fire-brick, built in during construction and laid in Flemish bond. The hearths will be raised and composed of the aforesaid brick, and finished with hard-wood borders. The hall, including stair-case, finished in quartered oak. The dining-room finish of cypress, and the entire second and third floors finished in California red-wood. The cost, when completed, including painting, glazing, and plumbing, which are special contracts, will be about $13,000.

PUBLIC LIBRARY, SOMERVILLE, MASS. MR. G. F. LORING, ARCHITECT, BOSTON, MASS.

Exterior face-brick, Longmeadow freestone trimmings, copper ridges, hips. finials, gutters and conductors; Brownville slate. All exterior walls hollow, interior walls, first story, brick, second story, wood; mill floors, second-story floors plastered one inch thick, felt on top; furrings on exterior walls plastered between seven-eighths of an inch on the brick walls; indirect steam, first floor, direct, second floor; inside finish, cherry throughout, with cherry ceilings and beams, first story rooms; vestibule in oak; vestibules and hall, marble tile; all other floors birch. Cost of exterior and rough carpentry work, $13,300; cost of interior finish, plaster, painting, furniture, tiles, grates, gas-fixtures, book-cases, etc., $10,000; cost of heating apparatus, complete, $1,175; cost of grading, walks, asphalt roadways and architects commission about $1,600. Total cost, $26,075.

NEW THEOLOGICAL HALL, HAMILTON, ONTARIO, CANADA. MR. T. J. LACEY, ARCHITECT, BINGHAMTON, N. Y.

This building is constructed of native stone, quarried from the College grounds, laid in broken ashler, rock face, laid with black joint, relieved with Trenton pressed brick, laid in red mortar, with ornamental brick and terra-cotta trimmings. The interior is finished with native woods. The first story, including the panelled wainscoting, stairways and the wainscoting of the corridors of the upper stories, are finished with quartered oak.

DESIGN FOR A GATE LODGE. MR. H. A. HOWES, JR., ARCHITECT, NEW HAVEN, CONN.

OLD COLONIAL WORK, NOS. IX AND X. DETAILS FOR TRINITY CHURCH, NEWPORT, R. I. MEASURED AND DRAWN BY MESSRS. A. H. EVERETT AND F. E. WALLIS.

SAFE BUILDING.[1]—IV.

The amounts given in Table IV for compression, tension and shearing are *along* fibres, except where marked *across*.

It will also be noticed that the factors-of-safety chosen are very different; the reason being that where figures seemed reliable the factor chosen was low, and became higher in proportion to the unreliability of the figures. The tables, as they are, are extremely unsatisfactory and unreliable, though the writer has spent much time in their construction. Any one, who will devote to the subject even the slightest research, will find that there are hardly any two original experimenters who agree, and in most cases, the experiments are so carelessly made or recorded that they are of but little value.

TRANSVERSE STRENGTH. — RUPTURE.

If a beam is supported at two ends, and loads are applied to the beam, it is evident: —

1st, that the beam will bend under the load, or *deflect*.

2d, that if the loading continues, the beam will eventually break, or be *ruptured*.

Deflection when non-important. The methods of calculating deflection and rupture differ very greatly. In some cases, where deflection in a beam would do no damage—such as cracking plaster, lowering a column, making a floor too uneven for machinery, etc.,—or where it would not look unsightly, we can leave deflection out of the question, and calculate for rupture only. Where, however, it is important to guard against deflection, we must calculate for both.

REACTION OF SUPPORTS.

If we imagine the loaded beam supported at both ends by two giants, it is evident that each giant would have to exert a certain amount of force upwards to keep his end of the beam from tipping.

Amount of Reaction. We can therefore imagine in all cases the supports to be resisting or *reacting* with force sufficient to uphold their respective ends. The amount of this reaction for either support is equal to the load multiplied by its distance from the further support, the whole divided by the length, or

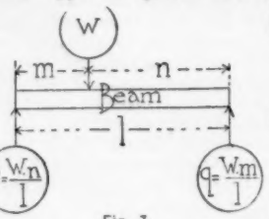

Fig. 7.

$$p = \frac{w.\ n}{l} \qquad (14)$$

Where p = the amount of the *left* hand reaction or supporting force.

and $$q = \frac{w.\ m}{l} \qquad (15)$$

Where q = the amount of the *right* hand reaction or supporting force.

If there are several loads the same law holds good for each, the reaction being the sum of the products, or

$$p = \frac{w_{\text{I}}\ n}{l} + \frac{w_{\text{II}}\ s}{l} \qquad (16)$$

and $$q = \frac{w_{\text{I}}\ m}{l} + \frac{w_{\text{II}}\ r}{l} \qquad (17)$$

As a check add the two reactions together and their sum must equal the whole load, that is

$$p + q = w_{\text{I}} + w_{\text{II}}$$

Example.

A beam 9′ 2″ long between bearings carries two loads, one of 200 lbs. 4′ 2″ from the left-hand support, and the other of 300 lbs. 3′ 4″ from the right-hand support. What are the right-hand and left-hand reactions?

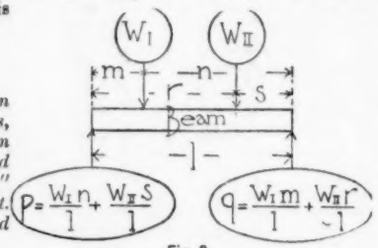

Fig. 8.

Referring to Figure 8 we should have $w_{\text{I}} = 200$ lbs., and $w_{\text{II}} = 300$ lbs., further $l = 110''$; $m = 50''$; $n = 60''$; $s = 40''$, and $r = 70''$, therefore the left-hand reaction would be: —

$$p = \frac{200.\ 60}{110} + \frac{300.\ 40}{110} = 218\tfrac{2}{11} \text{ pounds.}$$

and the right-hand reaction would be: —

$$q = \frac{200.\ 50}{110} + \frac{300.\ 70}{110} = 281\tfrac{9}{11} \text{ pounds.}$$

As a check add p and q together, and they should equal the whole load of 500 lbs., and we have in effect: —

$$p + q = 218\tfrac{2}{11} + 281\tfrac{9}{11} = 500 \text{ pounds.}$$

If the load on a beam is uniformly distributed, or is concentrated at the centre of the beam, or is concentrated at several points along the beam, each half of beam being loaded similarly, then each support will react just one half of the total load.

THE PRINCIPLE OF MOMENTS.

Law of Lever. The law of the lever is well known. The distance of a force from its fulcrum or point where it takes effect is called its *leverage*. The *effect* of the force at such point is equal to the amount of the force multiplied by its leverage.

Moment of a force. The *effect* of a force (or load) at any point of a beam is called the *moment* of the force (or load) at

[1] Continued from No. 545, page 271.

Glossary of Symbols.—The following letters, *in all cases*, will be found to express the same meaning, *unless distinctly otherwise stated*, viz.: —

a = *area*, in square inches.
b = *breadth*, in inches.
c = constant for *ultimate resistance to compression*, in pounds, per square inch.
d = *depth*, in inches.
e = constant for *modulus of elasticity*, in pounds-inch, that is, pounds per square inch.
f = *factor-of-safety*.
g = constant for *ultimate resistance to shearing*, per square inch, across the grain.
g_1 = constant for *ultimate resistance to shearing*, per square inch, lengthwise of the grain.
h = *height*, in inches.
i = *moment of inertia*, in inches. [See Table I.]
k = *ultimate modulus of rupture*, in pounds, per square inch.
l = *length*, in inches.
m = *moment or bending moment*, in pounds-inch.
n = *constant* in Rankine's formula for compression of long pillars. [See Table I.]
o = the *centre*.
p = the *amount* of the *left-hand re-action* (or support) of beams, in pounds.
q = the *amount* of the *right-hand re-action* (or support) of beams, in pounds.
r = *moment of resistance*, in inches. [See Table I.]
s = *strain*, in pounds.
t = constant for *ultimate resistance to tension*, in pounds, per square inch.
u = *uniform load*, in pounds.
v = *stress*, in pounds.
w = *load at centre*, in pounds.
x, y and z signify *unknown quantities*, either in pounds or inches.
δ = *total deflection*, in inches.
ρ^2 = *square of the radius of gyration*, in inches. [See Table I.]
$\mathfrak{D}$ = *diameter*, in inches.
$\mathfrak{r}$ = *radius*, in inches.
π = 3.14159, or, say, 3.1-7 signifies the *ratio of the circumference and diameter of a circle*.

If there are more than one of each kind, the second, third, etc., are indicated with the Roman numerals, as, for instance, a, a_{I}, a_{II}, a_{III}, etc., or b, b_{I}, b_{II}, b_{III}, etc.

In taking moments, or bending moments, strains, stresses, etc., to signify at what point they are taken, the letter signifying that point is added, as, for instance: —

m = moment or bending moment at *centre*.
m_{A} = " " " *point A*.
m_{B} = " " " *point B*.
m_{X} = " " " *point X*.
s = strain at *centre*.
s_{B} = " *point B*.
s_{X} = " *point X*.
v = stress at *centre*.
v_{D} = " *point D*.
v_{X} = " *point X*.
w = load at *centre*.
w_{A} = " *point A*.

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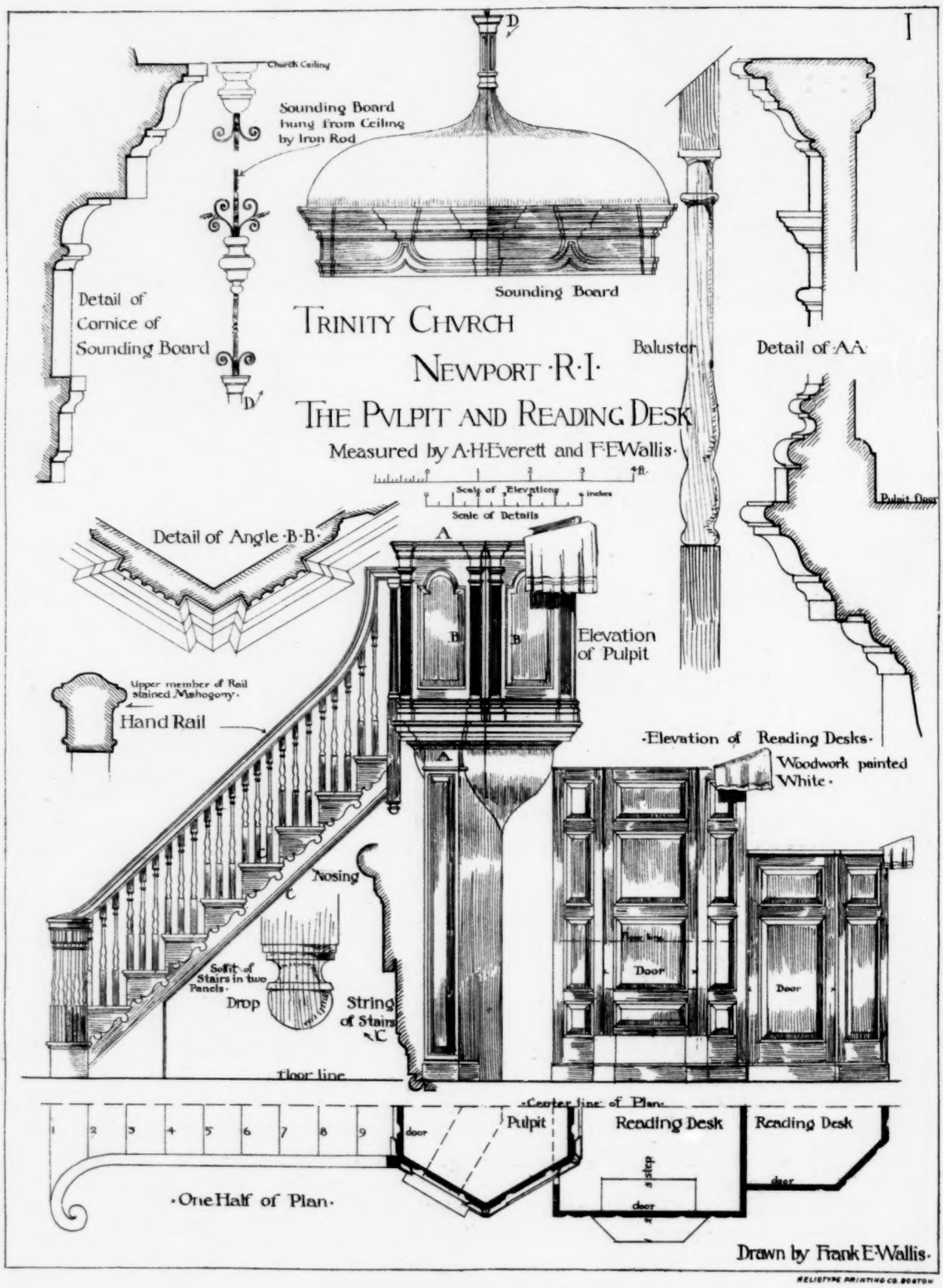

OLD COLONIAL WORK, IX.

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TROWBRIDGE, DET. MAY 1886.
RES. OF H.C. HULBERT, ESQ.
CLIFTON, S.I.
PLAMPTON & TROWBRIDGE, ARCHTS. N.Y.

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— First Story —

— Second Story —

— Rear —

— Side —

Perspective Sketch

H.A.H. & Del. June 86

Gate Lodge

by

H. A. Howe Jr., Archt

New Haven, Conn.

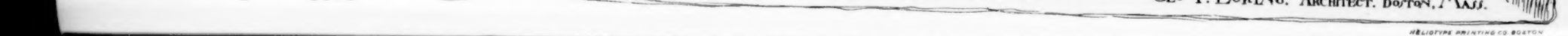
— Materials —

First Story — Pasture Stone.

Second " — Rough Cast

Roof — Red Tile —

HELIOTYPE PRINTING CO. BOSTON



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American Architect and Building News, July 31 1886. No. 549

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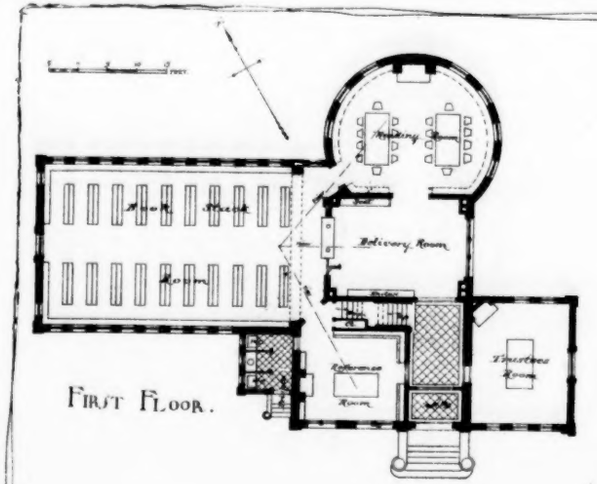
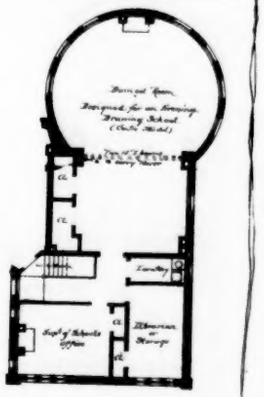


First Floor.



Second Floor.

Geo F. Loring. Architect. Boston, Mass.

HELIOTYPE PRINTING CO. BOSTON

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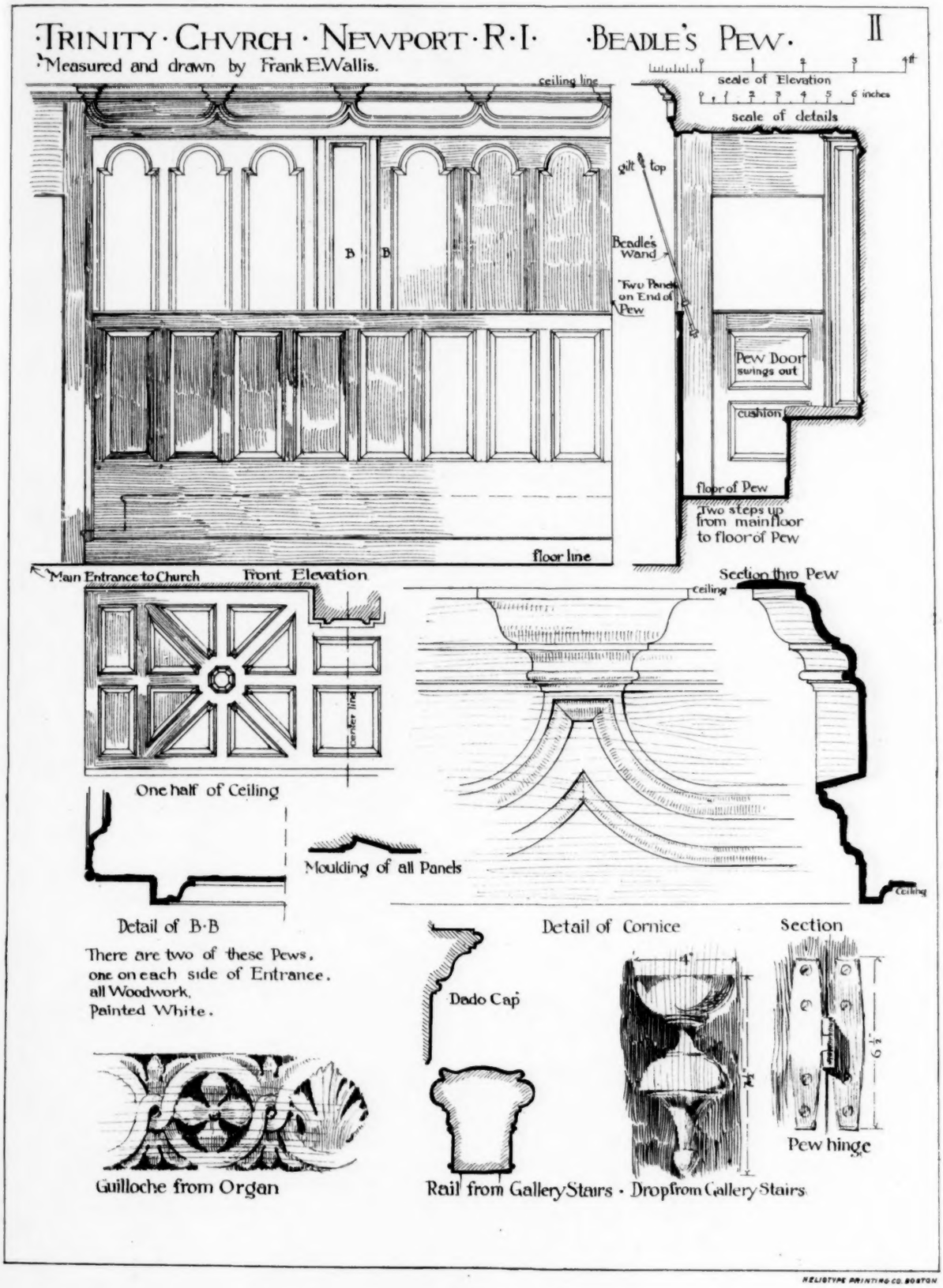


HELIOTYPE PRINTING CO. BOSTON

Old Colonial Work, X.

TABLE IV.

STRENGTH OF MATERIALS PER SQUARE INCH.

WOODS.	Compression. Ultimate c	Compression. Safe $\frac{c}{f}$	Tension. Ultimate t	Tension. Safe $\frac{t}{f}$	Shearing. Ultimate g or g_1	Shearing. Safe $\frac{g}{f}$ or $\frac{g_1}{f}$	Modulus of Rupture. Ultimate k	Modulus of Rupture. Safe $\frac{k}{f}$	Modulus of Elasticity. e	Weight per Cubic ft.
Acacia	—	—	11000	1100	—	—	7000	1400	1150000	48
Alder	6900	700	9500	1000	—	—	4000	800	800000	38
Apple	—	—	13000	1300	—	—	4500	900		50
Ash, English	8000	800	10500	1000	—	—	7800	1300	1200000	48
" American	8000	800	11000	1100	g_1 = 650	65	8000	1350	1250000	40
" " across	2060	200	—	—	g = 6000	600	—	—	—	—
" Canadian	5000	500	6500	650	g_1 = 1400	140	5000	850	1000000	38
Bamboo	—	—	6000	600	—	—	—	—	—	25
Baywood	7200	720	10500	1000	—	—	—	—	—	—
Beech	8000	800	8000	800	g = 5000	500	6000	1000	1350000	48
Birch, English	5000	500	10000	1000	—	—	6000	1000	1250000	47
" American	8500	850	10000	1000	g_1 = 650	65	5800	950	1300000	43
" " across	1800	180	—	—	g = 5400	560	—	—	—	—
Box	10000	1000	15000	1500	—	—	7500	1250	2000000	62
Cedar	6000	600	8000	800	—	—	7000	800	500000	41
" across	1950	200	—	—	g = 1400	140	—	—	—	—
Cherry	8000	800	—	—	—	—	4500	900	1200000	40
" across	2400	240	—	—	g = 2900	290	—	—	—	—
Chestnut, American	5300	530	8500	850	g_1 = 700	70	5400	900	750000	41
" " across	840	84	—	—	g = 1500	150	—	—	—	—
" English	—	—	10000	1000	—	—	8000	800	1000000	38
Crab	6800	680	—	—	—	—	4500	750	—	—
Deal	6000	600	8500	850	g_1 = 625	60	4800	800	—	30
Ebony	18000	1800	18000	1800	g = 7500	750	18000	2000	—	76
Elder	8700	870	10000	1000	—	—	4500	900	—	43
Elm, English	8000	800	8000	800	g_1 = 1200	120	5000	800	700000	35
" " across	—	—	—	—	g = 3000	300	—	—	—	—
" Canadian	8500	850	9000	900	g_1 = 1400	140	9000	900	2000000	47
" " across	—	—	—	—	g = 5000	500	—	—	—	—
Fir, Riga	6000	600	7500	750	—	—	7000	700	870000	40
" New England	6760	670	7500	750	g_1 = 690	70	4000	800	1000000	40
" " across	1200	120	690	70	—	—	—	—	—	—
Greenheart	13000	1300	8000	800	—	—	9500	950	1500000	65
Gum	7000	700	10500	1000	5900	600	6000	900	1400000	62
Hazel	—	—	12000	1200	—	—	—	—	—	—
Hawthorn	—	—	7500	750	—	—	—	—	—	—
Hemlock	4500	450	7000	700	g_1 = 500	50	4500	750	800000	26
" across	500	50	550	55	g = 2710	275	—	—	—	—
Hickory, American	9500	1000	10000	1000	—	—	8000	1000	1100000	50
" " across	3000	300	—	—	g = 6500	650	—	—	—	—
Holly	5250	525	10500	1000	—	—	4500	900	—	—
Hornbeam	6600	660	14000	1400	—	—	6000	1000	750000	47
Jugeb	—	—	12500	1250	—	—	—	—	—	—
Lancewood	—	—	18000	1800	—	—	—	—	—	52
Larch	4500	450	7000	700	g_1 = 1300	130	5500	700	1000000	35
" across	1300	130	1300	130	g = 3000	300	—	—	—	—
Lignum-vitæ	9900	1000	10000	1000	—	—	8000	1000	1080000	62
Locust, American	10000	1000	12000	1200	g_1 = 1150	120	10000	1100	1500000	46
" " across	3000	300	—	—	g = 7200	720	—	—	—	—
Mahogany	8200	820	11000	1100	—	—	6000	1000	1200000	45
" across	2400	240	—	—	—	—	—	—	—	—
Maple	6500	650	8000	800	g_1 = 450	45	7000	700	877000	45
" across	1875	200	—	—	g = 6000	600	—	—	—	—
Oak, American, Red	6000	600	8000	800	g_1 = 750	75	6500	800	1200000	52
" " White	7200	720	11000	1100	g_1 = 800	80	7200	1100	900000	52
" " " across	2400	240	2300	230	g = 4400	440	—	—	—	—
" Black bog	—	—	7700	770	—	—	—	—	—	—
" Canadian	6000	600	7500	750	—	—	7000	750	—	54
" Dantzic	7500	750	6000	600	g = 2300	230	6000	800	1165000	47
" English	8300	830	12000	1200	g_1 = 2316	230	6800	1100	873000	54
" " across	1800	200	2400	240	g = 4000	400	—	—	—	—
" Live	6850	700	11000	1100	g_1 = 700	70	7300	1100	—	69
" " across	4500	450	—	—	g = 8500	850	—	—	—	—
Pear	7800	750	8000	800	—	—	3400	700	800000	42
Pine, American yellow	5400	540	9000	900	—	—	6000	800	1100000	34
" " across	—	—	—	—	g = 4800	500	—	—	—	—
" " red	6500	650	9000	900	g_1 = 650	65	6100	800	900000	36
" " white	5500	550	9000	900	g_1 = 450	45	4000	900	850000	28
" " " across	700	70	550	60	g = 2500	250	—	—	—	—
" Canadian yellow	5300	570	6000	600	g_1 = 350	40	4800	600	1000000	33
" " " across	1425	150	—	—	g = 4300	430	—	—	—	—
" Georgia yellow	7400	750	12000	1200	g_1 = 500	50	7200	1200	1200000	45

WOODS.	Compression. Ultimate c	Compression. Safe $\frac{c}{f}$	Tension. Ultimate t	Tension. Safe $\frac{t}{f}$	Shearing. Ultimate g or g_1	Shearing. Safe $\frac{g}{f}$ or $\frac{g_1}{f}$	Modulus of Rupture. Ultimate k	Modulus of Rupture. Safe $\frac{k}{f}$	Modulus of Elasticity. e	Weight per Cubic ft.
Pine, Georgia Yel'w across	1850	200	—	—	g = 5700	570	—	—	—	—
" Pitch	8900	900	10000	1000	g_1 = 510	50	6600	1000	1225000	65
" " across	—	—	—	—	g = 5000	500	—	—	—	—
Plum	9000	900	8000	800	—	—	7000	900	—	45
Poon	—	—	9000	900	—	—	8000	900	1600000	—
Poplar (white wood)	5000	500	5500	550	g_1 = 400	40	4500	600	762000	27
" across	1000	100	1800	180	g = 4400	440	—	—	—	—
Redwood, California	6000	600	7300	750	—	—	4500	750	—	23
Spruce	6500	650	10000	1000	g_1 = 400	40	4400	1000	850000	30
" across	750	75	550	60	g = 3600	360	—	—	—	—
Sycamore	8100	810	10000	1000	—	—	6000	1000	1000000	40
Teak	12000	1200	14000	1400	—	—	8000	1300	1400000	46
Walnut	7000	700	8000	800	—	—	5500	800	900000	39
Walnut across	2100	210	—	—	g = 4000	400	—	—	—	39
Willow	6000	600	8500	850	—	—	4500	800	566000	25
Yew	—	—	6000	600	—	—	7000	700	—	50
METALS.										
Aluminium bronze	130000	25000	73000	12000	—	—	—	—	—	—
Antimony, cast	—	—	1100	200	—	—	—	—	—	418
Bismuth	—	—	3200	500	—	—	—	—	—	614
Brass, yellow, cast	80000	8000	28000	4500	37000	6000	20000	5000	9000000	506
" wire, unannealed	—	—	80000	8000	—	—	—	—	14000000	530
" " annealed	—	—	50000	5000	—	—	—	—	—	—
Bronze, gun-metal	120000	25000	32000	8000	—	—	53000	12500	10000000	529
" wire, unannealed	—	—	150000	30000	—	—	—	—	10000000	520
" " annealed	—	—	63000	13000	—	—	—	—	—	—
Copper, pure cast	117000	25000	30000	10000	33000	11000	22000	7000	10000000	543
" cast	—	—	25000	8000	—	—	—	—	—	—
" sheet wrought	103000	21000	34000	11000	—	—	—	—	15000000	556
" wire, unannealed	—	—	63000	20000	—	—	—	—	18000000	—
" " annealed	—	—	36000	12000	—	—	—	—	—	—
" bolts	—	—	32000	11000	—	—	—	—	—	556
Gold, cast	—	—	20000	5000	—	—	—	—	—	1204
" wire, unannealed	—	—	30000	7500	—	—	—	—	—	1217
" " annealed	—	—	5000	1250	—	—	—	—	—	—
Iron, cast, Am., 1" thick	85000	15000	16500	2500	18000	2500	40000	5000	15000000	454
" " English	70000	13000	13000	2000	14000	2000	36000	4000	12000000	450
" **wrought, American**	47000	12000	50000	12000	40000	8000	43000	12000	27000000	483
" " English	35000	9000	45000	11000	36000	7000	34000	10000	26000000	480
" corrugated	—	—	—	—	—	—	44000	20000	—	—
" wire ropes, unannealed	—	—	80000	20000	—	—	—	—	25300000	480
" " " annealed	—	—	50000	12000	—	—	—	—	15000000	—
" chains	—	—	35000	9000	—	—	—	—	—	—
" welded with steel, 5 ply	—	—	55500	14000	—	—	—	—	—	—
Lead, sheet	—	—	2500	500	—	—	—	—	—	—
" cast	7700	1200	2000	400	—	—	—	—	720000	712
" drawn pipe	—	—	1700	350	—	—	—	—	—	709
" wire	—	—	1400	300	—	—	—	—	—	—
Mercury at 32°	—	—	—	—	—	—	—	—	—	851
Nickel	—	—	—	—	—	—	—	—	—	488
Palladium, wire	—	—	50000	10000	—	—	—	—	—	—
" drawn	—	—	26000	5200	—	—	—	—	—	—
" annealed	—	—	7100	1500	—	—	—	—	—	—
Pewter	—	—	—	—	—	—	—	—	—	453
Platinum, wire, unannealed	—	—	55000	11000	—	—	—	—	—	1350
" " annealed	—	—	25000	5000	—	—	—	—	—	1379
Plumbago	—	—	—	—	—	—	—	—	—	142
Silver, cast	—	—	41000	8000	—	—	—	—	—	655
" annealed	—	—	4300	900	—	—	—	—	—	658
" wire, unannealed	—	—	38000	7600	—	—	—	—	—	—
Solder, soft	—	—	7500	1200	—	—	—	—	—	—
Steel, American, wrought	90000	15000	108000	18000	75000	12000	100000	15000	29000000	488
" English	—	—	95000	15000	65000	10000	80000	13000	28000000	490
" wire, unannealed	—	—	160000	25000	—	—	—	—	—	490
" " annealed	—	—	80000	13000	—	—	—	—	—	—
" rope, galvanized	—	—	6700	1200	—	—	—	—	—	—
" chains	—	—	42000	8500	—	—	—	—	—	—
" cast	150000	25000	85000	15000	57000	10000	125000	15000	30000000	—
" welded hard & soft, 5 ply	—	—	63300	15000	—	—	—	—	—	—
Tin, cast	15500	2500	5500	1000	—	—	4000	1000	4000000	462
" wire	—	—	7000	1200	—	—	—	—	—	—

TABLE IV. (*Continued.*)

STRENGTH OF MATERIALS PER SQUARE INCH.

MISCELLANEOUS.	Compression. Ultimate c	Compression. Safe $\frac{c}{f}$	Tension. Ultimate t	Tension. Safe $\frac{t}{f}$	Shearing. Ultimate g or g_1	Shearing. Safe $\frac{g}{f}$ or $\frac{g_1}{f}$	Modulus of Rupture. Ultimate k	Modulus of Rupture. Safe $\frac{k}{f}$	Modulus of Elasticity. e	Weight per Cubic ft.
Zinc, sheet	—	—	12000	2000	—	—	—	—	13500000	449
" wire	—	—	20000	3300	—	—	—	—	—	—
" cast	40000	7000	3300	600	—	—	7500	1200	—	438
MISCELLANEOUS.										
Bone	—	—	5000	500	—	—	—	—	—	—
Cement, Portland	3000	300	500	50	—	—	900	90	800000	81
Glass, common green	2800	1500	2850	300	—	—	4000	400	8000000	173
" crystal	17000	1000	2413	240	—	—	—	—	5800000	157
" flint	25003	1400	2300	230	—	—	—	—	—	—
" white crown	30000	1600	2500	250	—	—	—	—	—	—
" plate	—	—	5000	500	—	—	—	—	—	—
Ice, 32°	230	20	—	—	—	—	—	—	6000000	57
Ivory	—	—	16000	1600	—	—	—	—	—	114
Limestone	7000	700	1000	100	—	—	1500	150	3300000	146
Marble, Italian	12000	1200	700	70	—	—	2080	200	2500000	168
Mortar, lime	400	100	50	5	—	—	125	12	1285000	98
" Portland cement	2000	200	300	30	—	—	700	70	600000	109
Ox leather	—	—	4200	400	—	—	—	—	240000	—
Portland stone	3500	350	900	90	—	—	1530	150	1600000	146
Silk fibre	—	—	5200	520	—	—	—	—	1300000	—
Skin, ox undressed	—	—	6300	600	—	—	—	—	—	—
Slate	11000	1100	10000	800	—	—	5000	500	12000000	160
Ropes, hempen	—	—	8000	800	—	—	—	—	—	—
Whalebone	—	—	7700	770	—	—	—	—	820000	81
Yarn, flaxen	—	—	25000	1500	—	—	—	—	—	—

TABLE V.

STRENGTH OF STONES, BRICKS, AND CEMENTS PER SQUARE INCH.

STONES.	Compression on bed. Ultimate c	Compression on bed. Safe $\frac{c}{f}$	Compression on edge. Ultimate c_1	Compression on edge. Safe $\frac{c_1}{f}$	Tension. Ultimate t	Tension. Safe $\frac{t}{f}$	Modulus of Rupture. Ultimate k	Modulus of Rupture. Safe $\frac{k}{f}$	Weigh per Cubic ft.
Bluestone	13500	1350	—	—	1400	140	2300	230	160
Granite, average	15000	1500	—	—	580	50	1860	180	170
" Aberdeen (Scotch)	10700	1000	—	—	—	—	—	—	165
" Blue, Staten Island, N. Y	22250	2000	—	—	—	—	1300	130	179
" Canadian	12000	1200	—	—	—	—	—	—	162
" Connecticut	12000	1200	13000	1300	—	—	—	—	166
" Cornish (English)	6300	630	—	—	—	—	—	—	183
" Keene, N. H	14500	1450	—	—	—	—	1500	150	—
" Kingston (Dublin), Ireland	10450	1050	—	—	—	—	—	—	171
" Maine	15000	1500	15000	1500	—	—	—	—	168
" Massachusetts	16000	1600	9250	925	—	—	1870	180	165
" Millstone Point	15700	1570	—	—	—	—	1900	190	—
" Mt. Sorrel	12900	1300	—	—	—	—	—	—	—
" New Jersey	22000	2200	—	—	—	—	—	—	189
" New York State	15000	1500	15000	1500	—	—	—	—	168
" Peterhead (Scotch)	8300	830	—	—	—	—	—	—	166
" Virginia	14000	1400	—	—	—	—	—	—	164
" Greenstone, Giants' Causeway, Ireland	18000	1800	—	—	—	—	—	—	—
Limestone, average	7000	700	6000	600	1000	100	1500	150	146
" Anglesea, English	7600	760	—	—	—	—	—	—	—
" Bath, English	1450	150	—	—	—	—	370	37	—
" Caen, French	3550	350	—	—	150	15	600	60	119
" Chalk, average	1000	100	—	—	118	10	670	50	145
" Chilmark, English	3240	325	—	—	500	50	—	—	153
" Canton, Mo., drab	7200	720	—	—	—	—	—	—	146
" Marquette, Mich., drab	7900	790	7800	780	—	—	—	—	146
" Dublin, Irish	17000	1700	—	—	—	—	—	—	—
" English, compact	8300	830	—	—	—	—	800	80	160
" Glen Falls, N. Y	11500	1100	10750	1000	—	—	—	—	169
" Lake Champlain, N. Y	25000	2000	21500	1800	—	—	—	—	172
" North River, N. Y	17000	1500	14150	1400	—	—	—	—	166
" Purbeck (hard bed), English	8000	800	—	—	—	—	—	—	153

TABLE V. (*Continued.*)

STRENGTH OF STONES, BRICKS, AND CEMENTS PER SQUARE INCH.

STONES.	Compression on bed. Ultimate c	Compression on bed. Safe $\frac{c}{f}$	Compression on edge. Ultimate c_1	Compression on edge. Safe $\frac{c_1}{f}$	Tension. Ultimate t	Tension. Safe $\frac{t}{f}$	Modulus of Rupture. Ultimate k	Modulus of Rupture. Safe $\frac{k}{f}$	Weight per Cubic ft.
Limestone, Portland, English	3500	350	—	—	900	90	1530	150	146
" Joliet, Ill., white	13000	1300	7050	700	—	—	—	—	159
" Marblehead, Ohio, white	11500	1150	—	—	—	—	—	—	152
Marble, average	8000	800	8000	800	700	70	1200	120	160
" Devonshire red (English)	7300	730	—	—	—	—	—	—	163
" Eastchester	13000	1300	—	—	1600	160	1900	190	179
" Illinois	9700	970	9800	980	1000	100	1200	120	159
" Italian	12000	1200	—	—	700	70	2080	200	168
" Vermont	7600	760	8670	870	675	67	1200	120	166
Rock, average	12000	1000	11000	1000	—	—	—	—	165
" quartz (American)	22000	1500	13000	1000	—	—	—	—	165
" Holyhead (English)	25000	1500	13700	1000	—	—	—	—	165
" hard, New York City	11250	1000	12500	1000	—	—	—	—	182
Sandstone, average	5000	500	—	—	150	15	1000	100	144
" Berlin, Ohio	14250	1000	12000	1000	—	—	—	—	—
" Belville, N. J. (brown)	11700	1000	10250	800	—	—	650	50	141
" Corsehill (red Scotch)	7760	700	—	—	—	—	—	—	154
" Gatelawbridge (red Scotch)	8500	750	—	—	—	—	—	—	152
" Little Falls, N. Y. (brown)	9850	980	9150	900	—	—	1730	170	140
" Craigleith (Scotch)	5500	550	—	—	450	45	770	77	144
" Longmeadow, (Worcester) brown	10300	1000	—	—	—	—	—	—	142
" Longmeadow, (Kibbe) red	12700	1200	—	—	—	—	—	—	149
" Middletown, Conn. (brown)	6950	690	5550	500	500	50	1000	100	148
" Amherst, Ohio (brown-gray)	6000	600	5450	500	105	10	—	—	135
" Bramley Falls, English	5900	550	—	—	—	—	—	—	142
" Dorchester, Nova Scotia (freestone)	9200	900	—	—	100	10	800	80	150
" " (olive)	4250	400	6050	600	—	—	—	—	150
" Drab Berea (Ohio)	8750	800	—	—	105	10	—	—	134
" Runcorn red, (English)	2100	200	—	—	—	—	—	—	129
" Yorkshire paving (English)	5600	500	—	—	—	—	750	75	166
Slate	11000	1100	—	—	10000	800	5000	500	160
Whinstone (Scotch)	8100	800	—	—	1450	140	—	—	—
Stonework	with	level,	dressed	beds	allow	4-10 of	strength	of	stone.
Rubblework	500	100	—	—	—	—	—	—	150
BRICKS.									
Bricks, light red	640	65	—	—	40	4	—	—	—
" good common	10000	800	—	—	200	20	600	60	100
" best hard	12000	1000	—	—	400	40	750	75	107
" Philadelphia, pressed	6000	600	—	—	—	—	650	65	105
" brown glazed (English)	1300	130	—	—	—	—	—	—	—
" fire (English)	1700	170	—	—	—	—	—	—	138
Brickwork, common	1000	100	—	—	50	5	—	—	110
" good	1500	150	—	—	100	10	—	—	131
" best, in cement mortar	2000	200	—	—	300	30	—	—	112
Terra-cotta	5000	400	—	—	—	—	—	—	110
Terra-cotta work	2000	200	—	—	—	—	—	—	112
CEMENTS, ETC.									
Cement, Rosendale	1500	150	—	—	290	29	400	40	56
" Portland	3000	300	—	—	500	50	800	80	81
" lime	600	60	—	—	—	—	200	20	59
" plaster-of-Paris	600	60	—	—	70	7	—	—	78
Mortar, lime	400	100	—	—	50	5	125	12	98
" lime and Rosendale	550	125	—	—	75	8	200	20	100
" Rosendale cement	700	150	—	—	145	15	300	30	102
" Portland cement	2000	200	—	—	300	30	700	70	109
" plastering	400	50	—	—	—	—	—	—	86
Concrete, Portland cement	1500	200	—	—	427	40	162	16	150
" Rosendale cement	400	100	—	—	100	10	66	8	140
SOILS.									
Clay, horizontal layers	—	40	—	—	—	—	—	—	120
Firm earth	—	20	—	—	—	—	—	—	115
Gravel, firm with earth	—	100	—	—	—	—	—	—	125
Loam, soft	—	10	—	—	—	—	—	—	110
Sand, solid dry	—	40	—	—	—	—	—	—	112

TABLE VI.

WEIGHT PER CUBIC FOOT OF MATERIALS.

(Not included in Tables IV and V.)

Material.	Weight.	Material.	Weight.
Ashes	59	Peat	85
Asphalt	150	Petrified wood	145
Butter	60	Pitch	75
Camphor	63	Plumbago	131
Charcoal	23	Pumice-stone	56
Coal, solid	93	Resin	68
" loose	54	Rock crystal	172
Coke	50	Rubber	62
Cork	15	Salt	134
Cotton in bales	20	Saltpetre	130
Fat	58	Snow, fresh fallen	6
Gunpowder	56	" solid	20
Hay in bales	17	Sugar	82
Isinglass	70	Sulphur	125
Lead, red	560	Tiles	115
Paper	55	Water	63

said point, and is equal to the amount of the force (or load) multiplied by the distance of the force (or load) from said point, *the distance measured at right angles to the line of the force.* If therefore we find the moments — for all of the forces acting on a beam — at any single point of the beam we know the total moment at said point, and this is called the *bending-moment* at said point. Of course, forces acting in opposite directions will give opposite moments, and will counteract each other; to find the bending-moment, therefore, for any single point of a beam take the difference between the sums of the opposing moments of all forces acting at that point of the beam.

Bending moment.

Now on any loaded beam we have two kinds of forces, the loads which are pressing downwards, and the supports which are resisting upwards (theoretically *forcing* upwards). Again, if we imagine that the beam will break at any certain point, and imagine one side of the beam to be *rigid*, while the other side is tending to break away from the rigid side, it is evident that the effect at the point of rupture will be from one side only; therefore we must take the forces on *one side* of the point *only*. It will be found in practice that no matter for what point of a beam the bending moment is sought, the bending moment will be found to be the same, whether we take the forces to the right side or left side of the point. This gives an excellent check on all calculations, as we can calculate the bending moment from the forces on each side, and the results of course should be the same.

Now to find the actual strain on the fibres of any cross-section of the beam, we must find the bending moment at the point where the cross-section is taken, and divide it by the moment of resistance of the fibre, or,

$$\frac{m}{r} = s$$

Where m = the bending moment in lbs. inch.

Where r = the moment of resistance of the fibre in inches.

Where s = the strain.

The stress, of course, will be equal to the resistance to cross-breaking the fibres are capable of. In the case of beams which are of uniform cross-section above and below the neutral axis, this resistance is called the Modulus of Rupture (k). It is found by experiments and tests for each material, and will be found in Tables IV and V. We have, then, for *uniform cross-sections*: —

$$v = k$$

Where v = the ultimate stress per square inch.

Where k = the modulus of rupture per square inch. Inserting this and the above in the fundamental formula (1), viz.: $v = s.f.$, we have: —

$$k = \frac{m}{r}.f, \text{ or}$$

Transverse strength uniform cross-section.

$$\frac{m}{\left(\frac{k}{f}\right)} = r \qquad (18)$$

Where m = the bending moment in lbs. inch at a given point of beam.

Where r = the moment of resistance in inches of the fibres at said point.

Where $\left(\frac{k}{f}\right)$ = the safe modulus of rupture of the material, per square inch.

Transverse strength section not uniform.

If the *cross-section is not uniform* above and below the neutral axis, we must make two distinct calculations, one for the fibres above the neutral axis, the other for the fibres below; in the former case the fibres would be under compression, in the latter under tension. Therefore, for the fibres *above the neutral axis*, the ultimate stress would be equal to the ultimate resistance of the fibres to compression, or $v = c$.

Inserting this in the fundamental formula (1), we have: —

$$c = \frac{m}{r}.f, \text{ or}$$

Upper fibres.

$$\frac{m}{\left(\frac{c}{f}\right)} = r \qquad (19)$$

Where m = the bending moment in lbs. inch, at a given point of beam.

Where r = the moment of resistance in inches of the fibres at said point.

Where $\left(\frac{c}{f}\right)$ = the safe resistance to crushing of the material, per square inch.

For the *fibres below the neutral axis*, the ultimate stress would be equal to the ultimate resistance of the fibres to tension, or, $v = t$.

Inserting this in the fundamental formula (1) we have: —

$$t = \frac{m}{r}.f, \text{ or}$$

Lower fibres.

$$\frac{m}{\left(\frac{t}{f}\right)} = r \qquad (20)$$

Where m = the bending moment in lbs. inch at a given point of beam.

Where r = the moment of resistance in inches of the fibres at said point.

Where $\left(\frac{t}{f}\right)$ = the safe resistance to tension of the material, per square inch.

The same formulæ apply to cantilevers as well as beams.

The moment of resistance r of any fibre is equal to the moment of inertia of the whole cross-section, divided by the distance of the fibre from the neutral axis of the cross-section.

Greatest strains on extreme fibres.

The greatest strains are along the upper and lower edges of the beam (the extreme fibres); we, therefore, only need to calculate their resistances, as all the intermediate fibres are nearer to the neutral axis, and, consequently, *less* strained. The distance of fibres chosen in calculating the moment of resistance is, therefore, the distance from the neutral axis of either the upper or lower edges, as the case may be. The moments of resistance given in the fourth column, of Table I, are for the upper and lower edges (the extreme fibres), and should be inserted in place of r, in all the above formulæ.

Point of greatest bending moment.

To find at what point of a beam the greatest bending moment takes place (and, consequently, the greatest fibre strains, also), begin at either support and move along the beam towards the other support, passing by load after load, until the amount of loads that have been passed is equal to the amount of the reaction of the support (point of start); the point of the beam where this amount is reached is the point of greatest bending moment.

In cantilevers (beams built in solidly at one end and free at the other end), the point of greatest bending moment is *always* at the point of the support (where the beam is built in).

In light beams and short spans the weight of the beam itself can be neglected, but in heavy or long beams the weight of the beam should be considered as an independent uniform load.

THE ASH.

THE value of the ash largely lies in its white or pale color, and as there are no objectionable qualities in the white sap-wood, it is naturally preferred. It is the toughest wood natural to Europe, and is only surpassed by lancewood and young hickory in imported woods. This is especially the case in young trees grown on suitable soils. In the south of Europe it is not a tree to be admired, and is rarely allowed to grow in the neighborhood of houses or villages, from the attraction it has to the cantharide or Spanish fly, a blistering beetle fully one inch long and one-quarter of an inch broad. Mr. Giles Munby states in the *Magazine of Natural History*, Vol. IX, page 119, that he saw an ash tree overhanging the road near Dijon so crowded with these flies, that the excrement of the insects literally blackened the ground. On passing underneath the tree he felt his face as if bitten by gnats, and smelt a most disagreeable sickening smell, which extended twenty or thirty yards from the tree, according to the direction of the wind.

PROPERTIES AND USES OF THE ASH.

In the field of commerce the ash is introduced at an early age. At four or five years' growth it is fit for walking-sticks, whip-handles, etc.; a year or two later as poles for lances and for hop-growing; and it is then ready for the cooper, the turner, the chair-maker, and the manufacturer of small wares. It is also used for hoops, crates, handles of baskets, handles for hammers, and other tools. In this young state it is called "maiden ash," an old and somewhat poetic name, for trees are invariably alluded to in the feminine.

Another and very tough form of the young ash is the "stooled" i.e., the second growth from the original roots, a quality or form of reproduction that certain forest trees are endowed with.

The mature wood, except in the detail of size, possesses no special quality over the young or small wood; in neither form is it durable and free from the attack of worms (the larvæ of the furniture beetle), and hence it is never used as building timber. In this respect a marked distinction exists between the ash and the oak, the one being sweet and the other bitter in the secretionary matter forming the heartwood, and palatable or repulsive to animal life.

The uses to which large ash is applied is manifold. It is an important factor in the hands of the wheelwright and the agricultural-implement maker, as it has been from very ancient times; it is also largely used by the coachmaker and the carriage-builder. It is an admirable wood for chopping-blocks and shop-boards, and for all purposes where washing is required, as it will not readily splinter: it is also largely used for bobbins and tools, as trawl-beams for fishermen, and for numerous purposes in ship and boat building.

ASH AS COMPARED WITH OAK AND ELM.

The specific gravity of the ash is 736, the oak 827, and the elm 558. The elasticity of the ash is 1,289, the oak 1,000, and the elm 564. The following are the Admiralty tests on scantlings 2″ x 2″, placed on bearers 6 feet apart: —

The ash broke with 862 lbs., the oak with 837 lbs., and the elm with 393 lbs. The deflection at the crisis of breaking was: ash $8\frac{625}{1000}$ inches, oak, $7\frac{854}{1000}$ inches, and elm, $5\frac{291}{1000}$ inches.

It will thus be seen that the ash is lighter than the oak, but that it is stronger and more elastic. The elm, in comparison, occupies a very low position; but this is largely owing to the specimens operated upon being cut from matured wood, which was presumably in a dry state. Young elm or poles would compare much more favorably with ash, or otherwise we should not find them used in old times for bows or as substitutes for ash as trawl-beams in the fishing trade of to-day.

The great point in which the ash differs from the oak is in its durability; but this defect is largely overcome by keeping the wood well covered with paint. The worm is nevertheless its great enemy, and the dissolution of the wood at a very early stage, compared with the heart of oak, is largely traceable to its operations.

THE AMERICAN ASH.

This is the *Fraxinus Americana* of our botanists, an important tree, which abounds from Carolina to Canada, and is remarkable for the rapidity of its growth, often rising with a trunk 40 feet in length to the first branches, and a diameter of 3 feet. It prefers a cold climate, and location on the banks of rivers, or on the edges or acclivities of swamps.

It is commonly known in America as the "white ash," from the color of the bark, which is lighter than the English or European ash. In some instances it is called the "green ash," from the pale color of its leaves, especially when young.

The American ash grows well in Europe, and has the remarkable quality of being free from the attack of the Spanish fly, and may, in consequence, be planted with safety near dwelling-houses, where the European ash could not be tolerated; but, as with other trees of recent introduction, it is not so well known as its merits warrant.

The wood of the young trees or stools, being mostly sap-wood is white; but the heart-wood of mature trees, and hence that of imported logs, is reddish or inclined to brown in color.

The wood is used in one or other of its forms throughout America for all the purposes to which the European ash is applied in England; but when imported into this country the whitest logs are considered the best, and are much sought after by the cabinet-makers for bedroom furniture, the more colored logs being held as inferior, both in strength and durability, an impression that pervades the wood trade in general.

The American or Quebec ash, compared with oak and birch, is but sparingly imported into this country; it reaches us in partly-squared logs 18 to 30 feet long, 10 to 18 inches square, and latterly in the form of sawn planks.

The young or small wood being tough, is largely made into boat oars, and the quality being uniformly good renders them in active demand in Europe. In some cases these oars are shipped in a wrought form, the operation being performed by machinery, in others they come to hand in a rough-hewn state.

The mature wood, when compared with English ash, is fine and soft, and in consequence is taken up by the cabinet-maker for drawer and carcase works, branches of trade altogether strange to our native ash. When used for legitimate ash purposes it is accounted inferior to that of English growth.

One quality possessed by the American ash is that of standing well in work when once it is properly dried. In this respect it is very distinct from English ash, which is rarely, if ever, used for panel purposes by coach-builders or cabinet-makers. Another quality possessed by this wood is that of being easy to work, a great consideration where labor is a costly item.

It is clear from the above that, although it is used in America for all purposes to which European ash is applied in England, it is used for other purposes upon reaching this country, and is practically treated as a distinct class of wood.

For purposes of competition the American hickory is imported; this and lancewood being the only successful rivals of the English ash, the American ash, except in the young wood, scarcely winning a place.

AMERICAN COMPARED WITH ENGLISH ASH, ETC.

Having set up a standard of comparison for the English ash, we can apply the guage to the American species with a great amount of confidence.

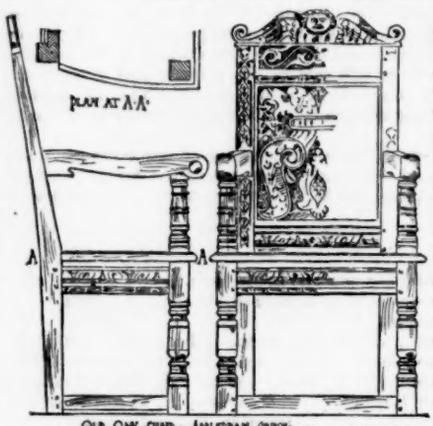
The specific gravity of the American ash is 588, against English 736; its elasticity is 773 against 1,289, it weight per cube foot 30 lbs. against 46 lbs. On scantlings as above, the American broke with 638 lbs., whilst it required 862 lbs. in the case of English wood. The deflection at the crisis of breaking was $7\frac{875}{1000}$ against $8\frac{625}{1000}$.

From the above it will be seen that the American wood is about one-fourth less in its specific gravity than the English, its elasticity being fully one-third less. The breaking weight of the American is fully one-fourth less than the English, but the deflection at the crisis of breaking is not so marked, whilst the weight per cubic foot is one-third less.

The wood is undoubtedly inferior to that of European growth, and if, as contended by Darwinian students, it is merely a variety of an original stock akin to that of European growth, the inferiority can only be traced to its acquiring in some degree the habits of an aquatic plant, by which the fibrous system has gradually declined in favor of an increase of cellular tissue until the change has become radical.

In America there are other species of ash; the "brown-barked," *F. pubescens*, which produces a reddish-colored wood; the "black-barked ash," or water ash, *F. sambucifolia;* the green ash, otherwise the Western black ash or walnut-leaved ash, *F. juglandifolia;* and the blue ash *F. quadrangulata*. The wood of these is more or less used for local purposes, but as they sparingly enter into commerce, when compared with the white ash, they merit nothing further at our hands than a passing notice.—*Timber Trades Journal.*

THE TOWERS OF SILENCE.



Old Oak Chair, Amsterdam (circa Angel Land) London: Architectural Publication Society

On the northeast crest of Malabar Hill are situated the famous Towers of Silence. There are two approaches to the extensive tract of ground on which they are built. From the Gowalia Tank road towards the north a winding avenue of recent construction leads to the gateway at the top, on which is an inscription that none but Parsees may enter there. This prohibition was rendered necessary, it is said, by the unseemly and inconsiderate conduct of those who used formerly to be admitted within the enclosure. The gateway is also reached by a sort of giant staircase, half a mile long, which, starting from the Gaumdvi road, close to Back Bay, comes almost straight up the hill. Both approaches are strikingly picturesque.

The visitor who has obtained permission to disregard the notice at the entrance will find, on passing the portals, that he is in a kind of small court-yard, from which he can only advance by mounting some half-dozen steps. On the right is the Suggree, a low stone building, open on all sides, in which prayers are offered for the dead. The chief object of having the court-yard lower than the level on which the Suggree is built is to prevent the ceremonies from being profaned by the gaze of unbelieving eyes. When the mourners are numerous they group themselves around the building, and from its being open they can, of course, see all that goes on within, and take part in the prayers. The dead, it should be mentioned, are never taken within the Suggree. Between the Suggree and the garden is a large and handsome building, with arched roof, designed to supersede the present Suggree, which is found to be inconveniently small. Passing this new erection we enter a beautiful garden ablaze with flowers, amongst which roses are conspicuous. Along the walks are iron garden-seats of elegant structure and European make. Here the relatives of the dead rest after the toilsome ascent of the basalt staircase, and on subsequent occasions come to pray. Beyond the garden, on the undulating summit of the hill looking towards Malabar Point, is the park-like, grass-covered tract, in which, at irregular intervals, are the Towers of Silence, where the dead are laid. The Towers, of which there are six, are round, and, on an average, from thirty to forty feet high, and as much in diameter; one or two are, perhaps, higher. They are solidly built of stone, the walls being some three feet thick, and they are all colored white. There is no window, and only one door, covering a small aperture about a third of the way up. To this aperture access is obtained by a narrow stone causeway, up

which the dead and the bier-bearers alone may venture. So sacred are the towers that no one except the bearers who are set apart for the purpose may approach within thirty paces of them. Inside, on the rock pavement, spaces are marked out on which the dead are placed to await the vultures, and pathways are marked out for the bearers to walk upon without defiling the place where their unconscious burdens are to rest.

When a Parsee dies his soul goes to heaven, but his body must not be tainted by corruption. Therefore it is at once washed and purified, and if there be yet time it is at once carried to the towers before sundown. If death takes place, however, after, say, three o'clock, when there would not be time to gain the towers and pray becomingly before dark, the body is kept till the early morning. Having been rendered undefiled, it is clothed in white, and prayers are offered at the house by family and friends. None may henceforth touch it; it is pure and must so remain. The women of the family take a last look, and the light bier on which it has been placed being covered with a white shroud it is carried by the bearers to the hill. No vehicle can on any account be used; no one must even follow in a vehicle; the whole journey, no matter what the distance, must be made on foot. All who form part of the *cortege* must have been washed and purified and clothed in white, and to touch any one would be to become defiled. The women in some cases wear mourning — black — but the men never. No woman attends a funeral; the female relatives of the dead always remain at home on that day, but they may, and do, go afterwards to the garden near the towers to pray.

Carrying the body and following it in procession, holding scarfs passed from one side to the other, those forming the *cortege* wend their way slowly to the foot of the steps leading to the top of Malabar Hill. Laboriously ascending these, they reach the crest in a quarter of a hour, and the priests go through the sacred ceremonies in the Suggree. Some Parsees consider that the prayers thus rendered have the effect of averting all decomposition or other defilement; but this view is not universally entertained. When the prayers are over, and those who have come a long and weary journey are somewhat rested, the body is borne to the foot of the causeway leading to the door of one of the towers. Here the face is uncovered, so that all may take a last, lingering look; it is covered again, and the form disappears into the tower.

Were there not serious misconceptions to be removed we would not seek further to penetrate these mysteries; but, as stories in which there is more of horror than of fact are rife amongst those who know absolutely nothing of what really takes place, it is better that the truth should be fully told. The towers are scattered over a large and park-like enclosure, secluded by its elevation from every eye. Outside the lofty wall which encircles the whole space there are hundreds of acres of land, partially cultivated, which the Parsees claim, and which while in their possession they have carefully kept as a sort of neutral territory between the domain of outsiders' bungalows and that of the towers. What goes on inside, therefore, no one can see, and, of course, no one need be offended at. It is the imagination alone that is shocked, and it is more easily shocked from being quite uninformed of what really happens. What happens is this: some fifty vultures make their abode in the lofty palms within the enclosure, and when the dead is deposited in towers, they swoop down and do not rise again till all the flesh has disappeared. In a few hours none of the body remains except the bones. Those who retail stories about fragments of human bodies being taken up by the vultures and carried outside the park and the surrounding neutral belt, and then being dropped on the roads, are ignorant of the habits of these jackals of the air. On the American pampas, when they alight upon their quarry, they are so loth to quit the spot that they are eventually unable to fly from it on the approach of horsemen, who find no difficulty in knocking them over with their whips. Within the towers they are secluded from all disturbance, and those who have watched for the purpose have never seen them come to the top with any substance whatever. It is only when all is over that they come to the summit of the towers, where they remain for hours without moving. Then they take their heavy flight to the palms around; seldom, indeed, do they go beyond the trees in the rough ground outside the vast compound. There is nothing of a sacred character ascribed to these useful but obscene birds. They are regarded simply as a means of preventing decomposition, and in accomplishing that task they perfectly succeed. The consequence is, that the grounds about the Towers of Silence have nothing of the hideous taint of the charnel-house. There is nothing obnoxious to health; there is not the faintest odor of death to mingle with the perfume of the roses blooming around.—*The Times of India.*

COMMUNICATIONS

[*We cannot pay attention to the demands of correspondents who forget to give their names and addresses as guaranty of good faith.*]

MASTIC.

CHICAGO, ILL., June 26, 1886.

TO THE EDITORS OF THE AMERICAN ARCHITECT:—

Dear Sirs,—I have had occasion to make some alterations and repairs in an old building, erected about thirteen years ago, the front of which is composed of what the owner says was called "French Mastic," and that marble-dust, litharge, boiled-oil and color were some or all of its ingredients. The recipe was taken from some book, but he does not remember what one.

I wish to patch up this old front in places, and would like to obtain the recipe for the "French Mastic," and any information that you can give me will be thankfully received.

You may answer through the columns of your weekly, or by letter, as you see fit. Yours respectfully, EDW. C. REMICK,

[WE presume the formula for French mastic was, fifty parts of marble dust to ten parts red lead, and enough boiled linseed-oil to moisten the mixture—just enough to make it work easily under the trowel. Before applying the mastic, the wall should be given three coats of boiled linseed-oil, giving time for each coat to dry thoroughly. It takes some months to acquire its ultimate degree of hardness, though it gets its first set in a very short time. A mastic facing is expensive to maintain in good condition, since the evaporation of the oil used in mixing makes it necessary to paint or oil it at intervals.— EDS. AMERICAN ARCHITECT.]

A QUESTION OF FOUNDATIONS.

HARTFORD, CONN.

TO THE EDITORS OF THE AMERICAN ARCHITECT:—

Dear Sirs,—Which of these two foundations, in a heavy clay soil, is the better, other circumstances being equal?

1. Sandstone footing-course, 10″ thick, 3′ wide, and 5′ or 6′ long. Clay is moistened, then cement grouting applied, and the stones worked back and forth until a firm bed is obtained. A 2′ wall is built on this.

2. A trench is dug six inches lower than for footing stones, and sand dumped in and rammed down. On this, sandstones about 1′ 6″ x 2′ 6″, of irregular thicknesses, are laid, locking joints, the length of one stone, 2′ 6″, forming thickness of the wall. Cement grouting is poured in between the joints, and, after drying, the 2′ wall is laid, as in the other case, but locking more closely into the bottom course.

The former method has had my preference, but this one is strongly recommended as being less expensive and less likely to settle.

NARTHEX.

[So far as we can understand the situation, either method will give a good foundation, though we do not think that the larger sandstone footings, which our correspondent probably believes can be used to as much advantage as granite stones of the same dimensions, offer any better security against unequal settlement than the stones used in the second method. The idea of bedding the footing on a layer of sand is an excellent one when properly applied, but we question if a six-inch layer, which could all be easily absorbed by the underlying clay when saturated with moisture, will offer all the benefits which can be obtained by the use of sand in a foundation. *Engineering News* has within a couple of months published some interesting papers on the use of sand, which we commend to our correspondent's attention.— EDS. AMERICAN ARCHITECT.]

CAN A CORPORATION'S SALARIED SERVANT CLAIM THE PROTECTION OF "PROFESSIONAL USAGE"?

BALTIMORE, MD., June 3, 1886.

TO THE EDITORS OF THE AMERICAN ARCHITECT:—

Dear Sirs, — Can you direct me to any articles in your valuable paper, or any *practical* work on acoustics of public halls and theatres?

I also take the liberty of asking your opinion as to the right of possession of drawings executed as architect for a company or corporation, extending over a number of years and paid an annual salary, together with all office and travelling expenses in lieu of a commission. Does not the same rule or custom apply, or has the company any more right to demand or keep possession of *any* or all of the drawings upon termination of engagement than if the work had been done in the usual way on commission?

Yours respectfully, "OLD SUBSCRIBER."

[FOR what may be called a popular knowledge of acoustics, we recommend Dr. Lardner's "*Hand-book of Electricity, Magnetism and Acoustics:*" for the application of the principles of acoustics to buildings, we venture to suggest, though we have never seen the book, that Mr. T. Roger Smith's "*Rudimentary Treatise on Acoustics of Public Buildings,*" is probably as useful a work as any. These works can be obtained through any importing bookseller.

The second question can be answered more easily than those which are usually proposed concerning the vexed matter of the ownership of drawings—the importance of which, save in exceptional cases, we believe is generally overestimated by the profession. Our correspondent evidently entered the employ of the railroad like any other employé, and made no effort to inform the officials that he wished them to import with him all the usual professional customs, of which they were, of course, ignorant, and whose protection he can therefore hardly claim. Moreover, by accepting a salary in lieu of the usual recompense by percentage, he seems to have abandoned the rights and privileges of an independent professional — one of which is the debatable right to the drawings he makes — and to have become simply the company's salaried servant, and as such it unquestionably has the right to claim whatever he does in the special line of his work during the hours' work for which his salary is paid. In this case the "tools of service" argument cannot fairly be applied, for it must have been known to our correspondent, at the time he entered the company's service, that railroads have a way of duplicating their stations and other buildings, and that he was hired to make drawings quite as much as designs. Before a jury we think the company's lawyer would only have to suggest, to win his case, that our correspondent's claim under this plea was as reasonable as would be that of the head book-keeper who, at the expiration of his term of service, should seek to go off with the company's cash-book and journal, on the plea that they were "tools of service," maintaining that in leaving the ledger, which showed the results of the entries in the other books, he left all that the company could claim as its own.—EDS. AMERICAN ARCHITECT.]

THE EQUILIBRATION OF AN ARCH.

Bridgeport, Conn., May 26, 1886.

To the Editors of the American Architect:—

Dear Sirs,—Will you kindly give an opinion as to the stability of the arch shown by the enclosed sketch? One party claims that it is all right, and that the line of thrust lies sufficiently within the abutment, while another maintains that some sort of a tie will be required at the spring of arch. The arch carries no weight excepting its own and that of the roof above.

An early reply through the *American Architect* will be appreciated.

Subscriber.

Our correspondent has written a second letter, hoping to hasten our reply, so we will say that we have not found time to examine the matter, since it is a real problem, which requires time for its solution, which is propounded. If he will accept a snap judgment, we will say that the construction seems sufficiently safe, unless the belfry is actually to be used for bells: in that case we recommend him to be careful and discover the line and amount of his thrust; say by the method explained in the *American Architect* for July 2, 1881.—Eds. American Architect.]

NOTES & CLIPPINGS

Westminster Abbey.— If Westminster Abbey were to tumble down some fine morning because, owing to disruption bills and other political preoccupations, the Government could find no time to permit the Dean and Chapter to get possession of some portion of their own property in order to spend the proceeds on repairing the edifice of which they are the freeholders, the result would probably be by many people deplored as unfortunate. This is, however, at present, a by no means impossible contingency. By one of the beautiful examples of compensation in which nature is so rich, it had been arranged that as soon as the London smoke became injurious to the soft Caen stone of the Abbey the Chapter estates in Tyburnia should be built over so as to provide the necessary funds for repair. But Parliament stepped in and destroyed the balance by handing over all the income, except that which was necessary for ordinary working expenses to the Ecclesiastical Commission. And now Parliament must be appealed to, to undo its own handwork. As the Chapter estates are far more than sufficient to defray all the expense that it is now proposed to incur, it is possible that the bill will be allowed to pass without any protest against the wickedness of religious establishments and the diversion of national funds to sectarian purposes; though the most fanatical of Liberationists might well pause before describing the "great temple of reconciliation," which in the last few years has received Darwin and Livingstone and Stanley within its walls, as the church of a sect.— *St. James' Gazette.*

Painters and Sculptors.— The history of art is so rich in illustrations of precocity that it is difficult to select the best examples. Mantegna showed such marked ability as a child that he was taken up by a patron and entered by his master in the guild of painters before the completion of his eleventh year. Again, Andrea del Sarto is said to have shown fondness for drawing as a child, and at the early age of seven to have been introduced to the world of art in the shop of a goldsmith. Raphael seems to have been a painter from the cradle. He was sent to learn of Perugino when twelve years old, and at seventeen was painting on his own account. Tiziano showed as a child a decided preference for art over classics, and painted at the age of twelve a Madonna and Child in the tabernacle of a house, and about two years later studied under Gentile Bellini. Tintoretto used, as a child, to draw on the walls of his father's house, and received the name by which he is most widely known at this early date. Hardly less striking in his precocity is Michael Angelo, who as a lad kept running off to the studios, and at fourteen was received by Ghirlandajo as a regular pupil. Turning from Italy, we meet with no less interesting illustrations of artistic precocity. Murillo displayed talent as a child, covering the walls of his house with his drawings. It is said that he painted pictures as a boy and sold them at the fair. Holbein, who was taught at an early age by his father, painted finished pictures by the age of thirteen. Ruysdael is said to have painted notable pictures at twelve. At the same age Cornelius painted original compositions in the cathedral at Neuss which show great talent. Vernet helped when a boy to paint his father's pictures. Ary Scheffer, the son of a painter, painted from early childhood, and exhibited in the Amsterdam *Salon* at twelve. Among sculptors Canova is said to have carved a lion at twelve. Thorwaldsen entered on a regular course of study at eleven. Coming to our own country, we find instances of precocity which equal, if, indeed, they do not surpass, those furnished by other countries. Perhaps the most remarkable instance is George Morland. He is said to have taken to pencil and crayon almost as soon as he left the cradle. Sketches of his, made at four, five, and six, were exhibited to the Society of Artists, and won praise for the child artist. Sir Thomas Lawrence was another childish marvel. As a small boy he could draw portraits, and at nine not only copied historical paintings in a masterly style, but succeeded in compositions of his own. At ten his childish frame was such that he was sent by his father to Oxford to paint Bishops, Earls, and other notabilities—an experiment which brought great gain to his impecunious parent. At seventeen, the period of his riper and more lasting fame commenced. With these instances must be reckoned Landseer, who, taught by his father, could draw well at five, and excellently at eight. When only thirteen, he drew a majestic St. Bernard dog, which was etched by his brother, and in the same year pictures of his appeared in the Royal Academy under the name of Master E. Landseer. Gainsborough was a confirmed painter at twelve. Turner, though hampered by poverty, made such progress that he exhibited at fifteen. Wilkie says he could draw before he could read, and he exhibited at fourteen. Flaxman amused himself when a sickly child by drawing in crayons, and exhibited busts at fifteen.—*The Nineteenth Century.*

TRADE SURVEYS

Commercial and financial statistics from such trade centres as Boston, New York, Philadelphia and Chicago, which have been gathered during the past few days, reassert the favorable opinions which have been heretofore expressed. The clearing-house exchanges exhibit a very gratifying increase. Bank statements show an increase in the available money for lending, and the reserves are also increasing. This does not mean that less money is wanted for general use, but that we are practically departing more and more from the credit system; that collections are prompt; that there are comparatively few losses, and that the country at large is making more than it is spending. This fact is proven, also, by the growth of building and loan associations, by a wonderful expansion of manufacturing capacity, and by a general increment of invested capital. In fact, there is a perceptible hardening of prices, and here and there a slight advance in quotations. Cotton is in very active demand at good prices; wool has advanced and is booming upward; raw and finished silk goods are in active demand; the clothing, hosiery and carpet interests are especially busy, and the wholesale houses even now report a better demand than they have been accustomed to at this season. Fortunately, these improvements do not mean that we are about tumbling headlong into a period of over-production. The great captains of the industries know too well from past experience where the danger line runs. The improvement, while it is a positive one, is of such a conservative character that no downward tendency in prices is likely to grow out of it. The present trade forces beneath the surface will not be changed this year. The necessities are such that the present firmness in prices will continue even under an enlarging production. Railroad building begins next week in several of the Western States on a scale of magnitude not witnessed since 1882. About 150,000 tons of rail are to be delivered as fast as they can be loaded and shipped. In stock circles the bull movement is strong. It is due partly to the fact that all the standard securities are in demand. The larger manipulators are holding back. The smaller investors are coming forward. Considerable money is coming from the interior. Railroad properties like the Northern Pacific and the East Tennessee, Norfolk and Western are increasing in value and in demand. A good many railroad properties which have been hanging on the verge of bankruptcy are once more getting on their feet. This reference to railway and stock movements is proper at this time because of the effect that increasing earnings have upon general trade and business. Building activity is general. In the New England States it is more apparent in the smaller towns than in the larger. Through the Connecticut valley a great deal of work is under way. In the Hudson valley a large amount of work has been undertaken within a month. Real estate is bringing good prices. Movements are not of very large proportions because of the conservative policy pursued by large operators. Land is being bought as wanted, therefore whatever advance is made is sound. The shrinkage going on in prices, instead of doing harm, is laying stronger and broader foundation. No trifling will be done with financial questions in Congress. In fact, the contemplated issue of one and two dollar bills, points to a slight increase in the volume of currency. It is the commonsense course. If money is needed and silver will not go, it is sensible to put it in a shape that it will go, viz., in paper. While there is no scarcity of money, the necessities for more money are constantly growing. The great bulk of business men are giving more attention to the expansion of their business than to the getting of large profits. Throughout Pennsylvania and Ohio a great deal of building will be done this month. Some of it is entirely new. The manufacturing towns are taking the lead. A good deal of mill capacity is being added. It has been said before that the country is making more iron than ever, and this fact means a great deal. The manufacturers of machinery will, as a rule, employ more labor in July than heretofore, and contracts for autumn and winter work will be earnestly solicited at the low prices, which were established during the spring, when shop managers became more anxious for business. In the farther West architects and builders send very good reports. Very little trouble is apprehended from unsettled labor. The decrees of the labor leaders are being respected. Very few strikes have taken place. Employers have more confidence and are entering upon larger undertakings. The announcements of new enterprises, while not so frequent as early in the season, are sufficient. The best authorities in textile matters predict the largest autumn dry goods trade ever had since 1880. An increase in business is reported, due to the free arrival of Eastern centres, of buyers from jobbing markets in the West and South. Taking a glance at the coarser industries, it is to be observed that there is an evident improvement, if not of business actually arriving, there is an improvement in inquiries and in the presentation of probable requirements for river and lake tonnage, for railway rolling stock and equipments, and for material for large building enterprises. In the Ohio Valley quite an impetus has been given to industrial operations. The iron workers have concluded to work twelve months more at last year's wages. The nailers have resumed work at the old price. The action of these two branches will not be lost upon other labor associations. In the lumber trade a very heavy distribution is in progress, and there is no difficulty in disposing of large arrivals of lumber. In the Northwest more or less cutting of prices is reported within the past few days. All mills are running and large quantities of lumber are finding their way to market. The coal trade is in a temporarily depressed condition. Trade combinations have not been able to keep up prices, which are below last year's price in Eastern markets especially. The spirit of competition has broken out among the miners in Western coal fields, and the programme of peace marked out last winter at Columbus is in danger of being completely broken up. A federation of employers was attempted at New York a short time ago in order to protect themselves against the arbitrary action of labor organizations, but it was concluded to do nothing more than to recommend the employers in each separate industry to combine for their mutual protection. No general federation will be attempted, and, in fact, is not desirable, even if practicable. In fact, when employers study this labor question a little closer they will discover that the perfect organization of labor does not involve any surrender of an employer's just rights. Congress will do nothing of a practical nature with the labor question because it cannot. A labor committee is soliciting some legislation bearing upon labor interests, which can be passed without detriment to capital or much benefit to labor. The question of arbitration will settle itself outside of Congress. The question of wages will remain where it belongs, a question of agreement between employers and employed. The only loss which employers will suffer, if it is a loss, will be their ability to independently fix the value of labor, or to discharge employés without a cause which organized labor will recognize. Competition will continue to be a vital and ruling factor, in the regulation of wages, but an advantage will follow, viz., the controlling of competition between employers themselves, and those who sell their products.